

(10) **Patent No.:** US 9,381,059 B2
(45) **Date of Patent:** Jul. 5, 2016

- (56)
- References Cited**

- U.S. PATENT DOCUMENTS

- | | | | |
|---------------|---------|-------------------|---------|
| D223,367 S | 4/1972 | Kountz | |
| D263,020 S | 2/1982 | Rau, III | |
| D266,842 S | 11/1982 | Villers et al. | |
| D278,306 S | 4/1985 | McIntosh | |
| D295,893 S | 5/1988 | Sharkany et al. | |
| D295,894 S | 5/1988 | Sharkany et al. | |
| D354,218 S | 1/1995 | Van de Peer | |
| 5,853,412 A * | 12/1998 | Mayenberger | 606/51 |
| 6,010,516 A * | 1/2000 | Hulka | 606/148 |
| D424,693 S | 5/2000 | Pruter | |
| D424,694 S | 5/2000 | Tetzlaff et al. | |

- (Continued)

- FOREIGN PATENT DOCUMENTS

- | | | |
|----|---------|--------|
| CN | 1103807 | 6/1995 |
| DE | 390937 | 3/1924 |

- ## OTHER PUBLICATIONS

- U.S. Appl. No. 08/136,098, filed Oct. 14, 1993, Roger A. Stern.

- (Continued)

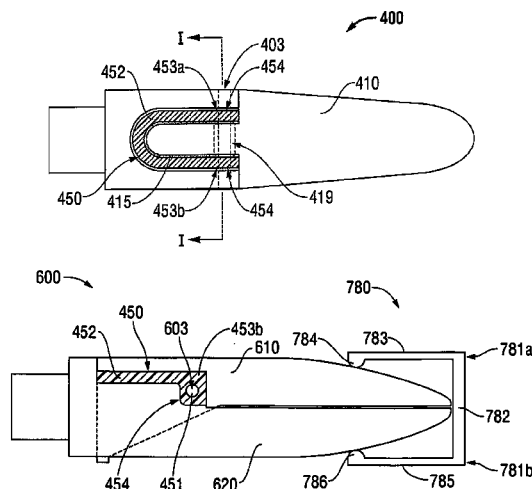
- Primary Examiner* — Ronald Hupczey, Jr.

- (58) **Field of Classification Search**
CPC A61B 18/085; A61B 18/1407–18/1447;
A61B 18/1815; A61B 2018/126; A61B
2018/0063; A61B 2018/00404; A61B
2018/1861; A61B 2018/00083; A61B
2017/2947
USPC 606/27–52, 208; 29/825–861
See application file for complete search history.

- (57) **ABSTRACT**

An end effector assembly suitable for use with a forceps includes opposing first and second jaw members pivotably mounted with respect to one another. The first jaw member includes one or more pivot holes defined therein configured to receive a portion of a pivot pin therein. The end effector assembly also includes an electrically-insulative hinge configured to electrically isolate the first and second jaw members from one another including one or more pivot-hole locators having an aperture defined therein. The electrically-insulative hinge is attached to the first jaw member such that the one or more pivot-hole locators align with the one or more pivot holes of the second jaw member.

14 Claims, 12 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

D425,201 S	5/2000	Tetzlaff et al.	DE	2602517	7/1976
6,096,037 A *	8/2000	Mulier A61B 18/1445	DE	2504280	8/1976
		606/49	DE	2627679	1/1977
6,238,414 B1 *	5/2001	Griffiths A61B 17/29	DE	2540968	3/1977
		606/205	DE	2820908	11/1978
D449,886 S	10/2001	Tetzlaff et al.	DE	2803275	8/1979
D457,958 S	5/2002	Dycus et al.	DE	2823291	11/1979
D457,959 S	5/2002	Tetzlaff et al.	DE	2946728	5/1981
6,669,696 B2 *	12/2003	Bacher et al. 606/51	DE	3143421	5/1982
D487,039 S	2/2004	Webster et al.	DE	3045996	7/1982
D496,997 S	10/2004	Dycus et al.	DE	3120102	12/1982
6,808,491 B2 *	10/2004	Kortenbach et al. 600/104	DE	3510586	10/1986
D499,181 S	11/2004	Dycus et al.	DE	3604823	8/1987
6,905,497 B2 *	6/2005	Truckai et al. 606/49	DE	8712328	3/1988
D525,361 S	7/2006	Hushka	DE	3711511	6/1988
7,103,947 B2	9/2006	Sartor et al.	DE	3904558	8/1990
D531,311 S	10/2006	Guerra et al.	DE	3942998	7/1991
D533,942 S	12/2006	Kerr et al.	DE	4238263	5/1993
7,150,097 B2	12/2006	Sremcich et al.	DE	4303882	8/1994
7,150,749 B2 *	12/2006	Dycus et al. 606/51	DE	4339049	5/1995
D535,027 S	1/2007	James et al.	DE	29616210	1/1997
7,156,846 B2	1/2007	Dycus et al.	DE	19608716	4/1997
D541,418 S	4/2007	Schechter et al.	DE	19751106	5/1998
7,204,835 B2 *	4/2007	Latterell et al. 606/48	DE	19717411	11/1998
D541,938 S	5/2007	Kerr et al.	DE	19751108	5/1999
D564,662 S	3/2008	Moses et al.	DE	19801173	7/1999
D576,932 S	9/2008	Strehler	DE	19848540	5/2000
D594,736 S	6/2009	Esjunin	DE	10224154	12/2003
D594,737 S	6/2009	Kelly et al.	DE	10310765	9/2004
7,540,872 B2 *	6/2009	Schechter et al. 606/50	DE	10328514	3/2005
7,553,311 B2 *	6/2009	Anders et al. 606/51	DE	102004022206	12/2005
7,566,334 B2 *	7/2009	Christian et al. 606/51	DE	202005015147	3/2006
7,597,693 B2	10/2009	Garrison	EP	0 246 350	11/1987
D606,203 S	12/2009	Husheer et al.	EP	0 521 264	1/1993
D613,412 S	4/2010	DeCarlo	EP	0 556 705	8/1993
7,776,065 B2 *	8/2010	Griffiths A61B 17/29	EP	0 558 429	9/1993
		606/207	EP	0 836 868	4/1998
D634,010 S	3/2011	DeCarlo	EP	0 882 955	12/1998
8,454,601 B2 *	6/2013	Sutter et al. 606/51	EP	1 159 926	5/2001
8,647,341 B2 *	2/2014	Dycus et al. 606/51	EP	0 648 515	4/2003
2002/0019632 A1 *	2/2002	Mayenberger 606/48	FR	179 607	11/1906
2002/0128649 A1 *	9/2002	Bacher et al. 606/46	FR	1 275 415	10/1961
2002/0183784 A1 *	12/2002	Lutze et al. 606/206	FR	1 347 865	11/1963
2002/0188294 A1 *	12/2002	Couture et al. 606/51	FR	2 235 669	1/1975
2003/0216733 A1 *	11/2003	McClurken et al. 606/51	FR	2 276 027	1/1976
2004/0193153 A1 *	9/2004	Sartor et al. 606/48	FR	2 313 708	12/1976
2004/0250419 A1 *	12/2004	Sremcich et al. 29/861	FR	2 502 935	10/1982
2005/0222602 A1 *	10/2005	Sutter et al. 606/192	FR	2 517 953	6/1983
2006/0264922 A1	11/2006	Sartor et al.	FR	2 573 301	5/1986
2007/0043352 A1 *	2/2007	Garrison et al. 606/51	FR	2 862 813	5/2005
2007/0078458 A1 *	4/2007	Dumbauld et al. 606/51	FR	2 864 439	7/2005
2007/0078459 A1	4/2007	Johnson et al.	JP	5-5106	1/1993
2007/0213712 A1 *	9/2007	Buyse et al. 606/51	JP	05-40112	2/1993
2007/0299439 A1 *	12/2007	Latterell et al. 606/48	JP	06343644	12/1994
2008/0058802 A1 *	3/2008	Couture et al. 606/48	JP	07265328	10/1995
2008/0243120 A1 *	10/2008	Lawes et al. 606/51	JP	08056955	3/1996
2009/0018535 A1 *	1/2009	Schechter et al. 606/33	JP	08252263	10/1996
2009/0048596 A1 *	2/2009	Shields et al. 606/51	JP	09000492	1/1997
2009/0171350 A1 *	7/2009	Dycus et al. 606/48	JP	09010223	1/1997
2009/0248052 A1	10/2009	Cunningham et al.	JP	11244298	9/1999
2010/0076430 A1 *	3/2010	Romero 606/51	JP	2000342599	12/2000
			JP	2000350732	12/2000
			JP	2001008944	1/2001
			JP	2001029356	2/2001
			JP	2001128990	5/2001
			JP	2001231870	8/2001
			JP	2008142467	6/2008
			SU	166452	11/1964
			SU	401367	11/1974
			SU	727201	4/1980
			WO	WO2010/035831	4/2010

FOREIGN PATENT DOCUMENTS

DE	1099658	2/1961
DE	1139927	11/1962
DE	1149832	6/1963
DE	1439302	1/1969
DE	2439587	2/1975
DE	2455174	5/1975
DE	2407559	8/1975
DE	2415263	10/1975
DE	2429021	1/1976
DE	2460481	6/1976

OTHER PUBLICATIONS

- U.S. Appl. No. 08/483,742, filed Jun. 7, 1995, Roger A. Stern.
U.S. Appl. No. 12/619,323, filed Nov. 16, 2009, Arnold V. DeCarlo.
U.S. Appl. No. 12/619,462, filed Nov. 16, 2009, Casey M. Ladtkow.
U.S. Appl. No. 12/620,289, filed Nov. 17, 2009, Joseph D. Brannan.
U.S. Appl. No. 12/642,623, filed Dec. 18, 2009, Prakash Manley.

(56)

References Cited

OTHER PUBLICATIONS

- U.S. Appl. No. 12/686,726, filed Jan. 13, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/692,856, filed Jan. 25, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/696,671, filed Jan. 29, 2010, Steven Kim.
- U.S. Appl. No. 12/696,966, filed Jan. 29, 2010, Steven Kim.
- U.S. Appl. No. 12/701,030, filed Feb. 5, 2010, Francesca Rossetto.
- U.S. Appl. No. 12/708,974, filed Feb. 19, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/709,014, filed Feb. 19, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/712,864, filed Feb. 25, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/713,429, filed Feb. 26, 2010, Anthony C. Lee.
- U.S. Appl. No. 12/713,515, filed Feb. 26, 2010, Anthony C. Lee.
- U.S. Appl. No. 12/713,641, filed Feb. 26, 2010, Anthony C. Lee.
- U.S. Appl. No. 12/719,657, filed Mar. 8, 2010, Mani N. Prakash.
- U.S. Appl. No. 12/722,034, filed Mar. 11, 2010, Casey M. Ladtkow.
- U.S. Appl. No. 12/731,367, filed Mar. 25, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/732,508, filed Mar. 26, 2010, Steven Kim.
- U.S. Appl. No. 12/732,521, filed Mar. 26, 2010, Steven Kim.
- U.S. Appl. No. 12/772,675, filed May 3, 2010, Brian Shiu.
- U.S. Appl. No. 12/777,984, filed May 11, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/786,671, filed May 25, 2010, Richard A. Willyard.
- U.S. Appl. No. 12/787,639, filed May 26, 2010, Mani N. Prakash.
- U.S. Appl. No. 12/792,904, filed Jun. 3, 2010, Ronald J. Podhajsky.
- U.S. Appl. No. 12/792,932, filed Jun. 3, 2010, Ronald J. Podhajsky.
- U.S. Appl. No. 12/792,947, filed Jun. 3, 2010, Ronald J. Podhajsky.
- U.S. Appl. No. 12/792,970, filed Jun. 3, 2010, Ronald J. Podhajsky.
- U.S. Appl. No. 12/793,037, filed Jun. 3, 2010, Ronald J. Podhajsky.
- U.S. Appl. No. 12/823,211, filed Jun. 25, 2010, Mani N. Prakash.
- U.S. Appl. No. 12/826,897, filed Jun. 30, 2010, Brian Shiu.
- U.S. Appl. No. 12/826,902, filed Jun. 30, 2010, Brian Shiu.
- U.S. Appl. No. 12/837,820, filed Jul. 16, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/839,023, filed Jul. 19, 2010, Ronald J. Podhajsky.
- U.S. Appl. No. 12/861,333, filed Aug. 23, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/944,951, filed Nov. 12, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/977,390, filed Dec. 23, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/977,415, filed Dec. 23, 2010, Joseph D. Brannan.
- U.S. Appl. No. 12/985,124, filed Jan. 5, 2011, Joseph D. Brannan.
- U.S. Appl. No. 12/985,136, filed Jan. 5, 2011, Joseph D. Brannan.
- U.S. Appl. No. 12/985,155, filed Jan. 5, 2011, Joseph D. Brannan.
- U.S. Appl. No. 12/985,179, filed Jan. 5, 2011, Joseph D. Brannan.
- U.S. Appl. No. 13/020,562, filed Feb. 3, 2011, Joseph D. Brannan.
- U.S. Appl. No. 13/020,664, filed Feb. 3, 2011, Kenlyn S. Bonn.
- U.S. Appl. No. 13/024,041, filed Feb. 9, 2011, Joseph D. Brannan.
- U.S. Appl. No. 13/029,521, filed Feb. 17, 2011, Joseph D. Brannan.
- U.S. Appl. No. 13/029,594, filed Feb. 17, 2011, Joseph D. Brannan.
- U.S. Appl. No. 13/043,665, filed Mar. 9, 2011, Richard A. Willyard.
- U.S. Appl. No. 13/043,694, filed Mar. 9, 2011, Richard A. Willyard.
- U.S. Appl. No. 13/050,729, filed Mar. 17, 2011, Casey M. Ladtkow.
- U.S. Appl. No. 13/083,185, filed Apr. 8, 2011, Arnold V. DeCarlo.
- U.S. Appl. No. 13/083,256, filed Apr. 8, 2011, Joseph D. Brannan.
- U.S. Appl. No. 13/098,199, filed Apr. 29, 2011, Roop L. Mahajan.
- Alexander et al., "Magnetic Resonance Image-Directed Stereotactic Neurosurgery: Use of Image Fusion with Computerized Tomography to Enhance Spatial Accuracy" *Journal Neurosurgery*, 83 (1995), pp. 271-276.
- Anderson et al., "A Numerical Study of Rapid Heating for High Temperature Radio Frequency Hyperthermia" *International Journal of Bio-Medical Computing*, 35 (1994), pp. 297-307.
- Anonymous. (1999) Auto Suture MIBB Site Marker: Single Use Clip Applier, United States Surgical (Product instructions), 2 pages.
- Anonymous. (2001) Disposable Chiba Biopsy Needles and Trays, Biopsy and Special Purpose Needles Cook Diagnostic and Interventional Products Catalog (products list), 4 pages.
- Anonymous. (1987) Homer Mammalok™ Breast Lesion Needle/Wire Localizer, Namic® Angiographic Systems Division, Glens Falls, New York, (Hospital products price list), 4 pages.
- Anonymous. (1999) MIBB Site Marker, United States Surgical (Sales brochure), 4 pages.
- Anonymous. Blunt Tubes with Finished Ends. Pointed Cannula, Popper & Sons Biomedical Instrument Division, (Products Price List), one page, Jul. 19, 2000.
- Anonymous. Ground Cannulae, ISPG, New Milford, CT, (Advertisement) one page, Jul. 19, 2000.
- B. Levy M.D. et al., "Randomized Trial of Suture Versus Electrosurgical Bipolar Vessel Sealing in Vaginal Hysterectomy" *Obstetrics & Gynecology*, vol. 102, No. 1, Jul. 2003.
- B. Levy M.D. et al., "Update on Hysterectomy New Technologies and Techniques" *OBG Management*, Feb. 2003.
- B. Levy M.D., "Use of a New Vessel Ligation Device During Vaginal Hysterectomy" FIGO 2000, Washington, D.C.
- B. F. Mullan et al., (May 1999) "Lung Nodules: Improved Wire for CT-Guided Localization," *Radiology* 211:561-565.
- B. T. Heniford M.D. et al., "Initial Research and Clinical Results with an Electrothermal Bipolar Vessel Sealer" Oct. 1999.
- Bergdahl et al., "Studies on Coagulation and the Development of an Automatic Computerized Bipolar Coagulator" *Journal of Neurosurgery* 75:1 (Jul. 1991), pp. 148-151.
- Bulletin of the American Physical Society, vol. 47, No. 5, Aug. 2002, p. 41.
- C. F. Gottlieb et al., "Interstitial Microwave Hyperthermia Applicators having Submillimetre Diameters", *Int. J. Hyperthermia*, vol. 6, No. 3, pp. 707-714, 1990.
- C. H. Durney et al., "Antennas for Medical Applications", *Antenna Handbook: Theory Application and Design*, p. 24-40, Van Nostrand Reinhold, 1988 New York, V.T. Lo, S.W. Lee.
- Carbonell et al., "Comparison of the Gyrus PlasmaKinetic Sealer and the Valleylab LigaSure™ Device in the Hemostasis of Small, Medium, and Large-Sized Arteries" *Carolinas Laparoscopic and Advanced Surgery Program*, Carolinas Medical Center, Charlotte, NC 2003.
- Carus et al., "Initial Experience With the LigaSure™ Vessel Sealing System in Abdominal Surgery" *Innovations That Work*, Jun. 2002.
- Chicharo et al., "A Sliding Goertzel Algorithm" Aug. 1996 DOS pp. 283-297 Signal Processing, Elsevier Science Publishers B.V. Amsterdam, NL, vol. 52, No. 3.
- Chou, C.K., (1995) "Radiofrequency Hyperthermia in Cancer Therapy," Chapter 94 In *Biologic Effects of Nonionizing Electromagnetic Fields*, CRC Press, Inc., pp. 1424-1428.
- Chung et al., "Clinical Experience of Sutureless Closed Hemorrhoidectomy with LigaSure™" *Diseases of the Colon & Rectum*, vol. 46, No. 1, Jan. 2003.
- Cosman et al., "Methods of Making Nervous System Lesions" in William RH, Rengachary SS (eds): *Neurosurgery*, New York: McGraw-Hill, vol. 111, (1984), pp. 2490-2499.
- Cosman et al., "Radiofrequency Lesion Generation and its Effect on Tissue Impedence", *Applied Neurophysiology*, 51:230-242, 1988.
- Cosman et al., "Theoretical Aspects of Radiofrequency Lesions in the Dorsal Root Entry Zone" *Neurosurgery* 15:(1984), pp. 945-950.
- Crawford et al., "Use of the LigaSure™ Vessel Sealing System in Urologic Cancer Surger" *Grand Rounds in Urology* 1999, vol. 1, Issue 4, pp. 10-17.
- Dulemba et al., "Use of a Bipolar Electrothermal Vessel Sealer in Laparoscopically Assisted Vaginal Hysterectomy" *Sales/Product Literature*; Jan. 2004.
- E. David Crawford, "Evaluation of a New Vessel Sealing Device in Urologic Cancer Surgery" *Sales/Product Literature* 2000.
- E. David Crawford, "Use of a Novel Vessel Sealing Technology in Management of the Dorsal Venous Complex" *Sales/Product Literature* 2000.
- Esterline, "Light Key Projection Keyboard" 2004 Advanced Input Systems, located at: <<http://www.advanced-input.com/lightkey>> last visited on Feb. 10, 2005.
- Esterline Product Literature, "Light Key: Visualize a Virtual Keyboard. One With No Moving Parts", Nov. 1, 2003; 4 pages.
- Geddes et al., "The Measurement of Physiologic Events by Electrical Impedence" *Am. J. MI*, Jan. Mar. 1964, pp. 16-27.
- Goldberg et al., "Image-guided Radiofrequency Tumor Ablation: Challenges and Opportunities—Part I", (2001) *JVasc. Interv. Radiol*, vol. 12, pp. 1021-1032.
- Goldberg et al. (1995) "Saline-enhanced RF Ablation: Demonstration of Efficacy and Optimization of Parameters", *Radiology*, 197(P): 140 (Abstr).

(56)

References Cited

OTHER PUBLICATIONS

- Goldberg et al., "Tissue Ablation with Radiofrequency: Effect of Probe Size, Gauge, Duration, and Temperature on Lesion Volume" *Acad Radio* (1995) vol. 2, No. 5, pp. 399-404.
- H. Schwarzaier et al., "Magnetic Resonance Imaging of Microwave Induced Tissue Heating" Dept. of Laser Medicine & Dept. of Diagnostic Radiology; Heinrich-Heine-University, Duesseldorf, Germany; Dec. 8, 1994; pp. 729-731.
- Heniford et al., "Initial Results with an Electrothermal Bipolar Vessel Sealer" *Surgical Endoscopy* (2001) 15:799-801.
- Herman et al., "Laparoscopic Intestinal Resection With the LigaSure™ Vessel Sealing System: A Case Report" *Innovations That Work*, Feb. 2002.
- Humphries Jr. et al., "Finite Element Codes to Model Electrical Heating and Non-Linear Thermal Transport in Biological Media", *Proc. ASME HTD-355*, 131 (1997).
- Ian D. McRury et al., *The Effect of Ablation Sequence and Duration on Lesion Shape Using Rapidly Pulsed Radiofrequency Energy Through Electrodes*, Feb. 2000, Springer Netherlands, vol. 4; No. 1, pp. 307-320.
- Jarrett et al., "Use of the LigaSure™ Vessel Sealing System for Peri-Hilar Vessels in Laparoscopic Nephrectomy" *Sales/Product Literature* 2000.
- Johnson et al., "Evaluation of a Bipolar Electrothermal Vessel Sealing Device in Hemorrhoidectomy" *Sales/Product Literature*, Jan. 2004.
- Johnson, "Evaluation of the LigaSure™ Vessel Sealing System in Hemorrhoidectomy" *American College of Surgeons (ACS) Clinic La Congress Poster* (2000).
- Johnson et al., "New Low-Profile Applicators for Local Heating of Tissues", *IEEE Transactions on Biomedical Engineering*, vol. BME-31, No. 1, Jan. 1984, pp. 28-37.
- Johnson, "Use of the LigaSure™ Vessel Sealing System in Bloodless Hemorrhoidectomy" *Innovations That Work*, Mar. 2000.
- Joseph G. Andriole M.D. et al., "Biopsy Needle Characteristics Assessed in the Laboratory", *Radiology* 148: 659-662, Sep. 1983.
- Joseph Ortenberg, "LigaSure™ System Used in Laparoscopic 1st and 2nd Stage Orchiopexy" *Innovations That Work*, Nov. 2002.
- K. Ogata, *Modern Control Engineering*, Prentice-Hall, Englewood Cliffs, N.J., 1970.
- Kennedy et al., "High-burst-strength, feedback-controlled bipolar vessel sealing" *Surgical Endoscopy* (1998) 12: 876-878.
- Kopans, D.B. et al., (Nov. 1985) "Spring Hookwire Breast Lesion Localizer: Use with Rigid-Compression Mammographic Systems," *Radiology* 157(2):537-538.
- Koyle et al., "Laparoscopic Palomo Varicocele Ligation in Children and Adolescents" *Pediatric Endosurgery & Innovative Techniques*, vol. 6, No. 1, 2002.
- LigaSure™ Vessel Sealing System, the Seal of Confidence in General, Gynecologic, Urologic, and Laparoscopic Surgery, *Sales/Product Literature*, Jan. 2004.
- Livraghi et al., (1995) "Saline-enhanced RF Tissue Ablation in the Treatment of Liver Metastases", *Radiology*, p. 140 (Abstr).
- Lyndon B. Johnson Space Center, Houston, Texas, "Compact Directional Microwave Antenna for Localized Heating," *NASA Tech Briefs*, Mar. 2008.
- M. A. Astrahan, "A Localized Current Field Hyperthermia System for Use with 192-Iridium Interstitial Implants" *Medical Physics*. 9(3), May/June. 1982.
- Magdy F. Iskander et al., "Design Optimization of Interstitial Antennas", *IEEE Transactions on Biomedical Engineering*, vol. 36, No. 2, Feb. 1989, pp. 238-246.
- McGahan et al., (1995) "Percutaneous Ultrasound-guided Radiofrequency Electrocautery Ablation of Prostate Tissue in Dogs", *Acad Radiol*, vol. 2, No. 1: pp. 61-65.
- McLellan et al., "Vessel Sealing for Hemostasis During Pelvic Surgery" *Int'l Federation of Gynecology and Obstetrics FIGO World Congress* 2000, Washington, DC.
- MDTECH product literature (Dec. 1999) "FlexStrand": product description, 1 page.
- MDTECH product literature (Mar. 2000) I'D Wire: product description, 1 page.
- Medtrex Brochure "The O.R. Pro 300" 1 page, Sep. 1998.
- Michael Choti, "Abdominoperineal Resection with the LigaSure™ Vessel Sealing System and LigaSure™ Atlas 20 cm Open Instrument" *Innovations That Work*, Jun. 2003.
- Muller et al., "Extended Left Hemicolectomy Using the LigaSure™ Vessel Sealing System" *Innovations That Work*, LJ, Sep. 1999.
- Murakami, R. et al., (1995). "Treatment of Hepatocellular Carcinoma: Value of Percutaneous Microwave Coagulation," *American Journal of Radiology (AJR)* 164:1159-1164.
- Ni Wei et al., "A Signal Processing Method for the Coriolis Mass Flowmeter Based on a Normalized . . ." *Journal of Applied Sciences—Yingyong Kexue Xuebao*, Shanghai CN, vol. 23, No. 2:(Mar. 2005); pp. 160-184.
- Ogden, "Goertzel Alternative to the Fourier Transform" Jun. 1993 pp. 485-487 *Electronics World*; Reed Business Publishing, Sutton, Surrey, BG, vol. 99, No. 9, 1687.
- Olsson M.D. et al., "Radical Cystectomy in Females" *Current Surgical Techniques in Urology*, vol. 14, Issue 3, 2001.
- Organ, L. W., "Electrophysiologic Principles of Radiofrequency Lesion Making" *Appl. Neurophysiol*, vol. 39: pp. 69-76 (1976/77).
- P.R. Stauffer et al., "Interstitial Heating Technologies", *Thermoradiotherapy and Thermochemotherapy* (1995) vol. I, Biology, Physiology, Physics, pp. 279-320.
- Palazzo et al., "Randomized clinical trial of LigaSure™ versus open haemorrhoidectomy" *British Journal of Surgery* 2002,89,154-157 "Innovations in Electrosurgery" *Sales/Product Literature*; Dec. 31, 2000.
- Paul G. Horgan, "A Novel Technique for Parenchymal Division During Hepatectomy" *The American Journal of Surgery*, vol. 181, No. 3, Apr. 2001, pp. 236-237.
- Peterson et al., "Comparison of Healing Process Following Ligation with Sutures and Bipolar Vessel Sealing" *Surgical Technology International* (2001).
- R. Gennari et al., (Jun. 2000) "Use of Technetium-99m-Labeled Colloid Albumin for Preoperative and Intraoperative Localization of Non palpable Breast Lesions," *American College of Surgeons*. 190(6):692-699.
- Valleylab Brochure, "Reducing Needlestick Injuries in the Operating Room" 1 page, Mar. 2001.
- Reidenbach, (1995) "First Experimental Results with Special Applicators for High-Frequency Interstitial Thermotherapy", *Society Minimally Invasive Therapy*, 4(Suppl 1):40 (Abstr).
- Richard Wolf Medical Instruments Corp. Brochure, "Kleppinger Bipolar Forceps & Bipolar Generator" 3 pages, Jan. 1989.
- Rothenberg et al., "Use of the LigaSure™ Vessel Sealing System in Minimally Invasive Surgery in Children" *Int'l Pediatric Endosurgery Group (I PEG)* 2000.
- Sayfan et al., "Sutureless Closed Hemorrhoidectomy: A New Technique" *Annals of Surgery*, vol. 234, No. 1, Jul. 2001, pp. 21-24.
- Sengupta et al., "Use of a Computer-Controlled Bipolar Diathermy System in Radical Prostatectomies and Other Open Urological Surgery" *ANZ Journal of Surgery* (2001) 71.9 pp. 538-540.
- Sigel et al., "The Mechanism of Blood Vessel Closure by High Frequency Electrocoagulation" *Surgery Gynecology & Obstetrics*, Oct. 1965 pp. 823-831.
- Solbiati et al., (2001) "Percutaneous Radio-frequency Ablation of Hepatic Metastases from Colorectal Cancer: Long-term Results in 117 Patients", *Radiology*, vol. 221, pp. 159-166.
- Solbiati et al. (1995) "Percutaneous US-guided RF Tissue Ablation of Liver Metastases: Long-term Follow-up", *Radiology*, pp. 195-203.
- Strasberg et al., "Use of a Bipolar Vessel-Sealing Device for Parenchymal Transection During Liver Surgery" *Journal of Gastrointestinal Surgery*, vol. 6, No. 4, Jul./Aug. 2002 pp. 569-574.
- Stuart W. Young, *Nuclear Magnetic Resonance Imaging—Basic Principles*, Raven Press, New York, 1984.
- Sugita et al., "Bipolar Coagulator with Automatic Thermocontrol" *J. Neurosurg.*, vol. 41, Dec. 1944, pp. 777-779.
- Sylvain Labonte et al., "Monopole Antennas for Microwave Catheter Ablation", *IEEE Trans. on Microwave Theory and Techniques*, vol. 44, No. 10, pp. 1832-1840, Oct. 1995.

(56)

References Cited**OTHER PUBLICATIONS**

- T. Matsukawa et al., "Percutaneous Microwave Coagulation Therapy in Liver Tumors", *Acta Radiologica*, vol. 38, pp. 410-415, 1997.
- T. Seki et al., (1994) "Ultrasonically Guided Percutaneous Microwave Coagulation Therapy for Small Hepatocellular Carcinoma," *Cancer* 74(3):817-825.
- Urologix, Inc.—Medical Professionals: Targis™ Technology (Date Unknown). "Overcoming the Challenge" located at: <<http://www.urologix.com/medicaUtechnology.html>> last visited on Apr. 27, 2001, 3 pages.
- Urrutia et al., (1988). "Retractable-Barb Needle for Breast Lesion Localization: Use in 60 Cases," *Radiology* 169(3):845-847.
- Valleylab Brochure, "Valleylab Electrosheild Monitoring System" 2 pages, Nov. 1995.
- ValleyLab Brochure, "Electosurgery: A Historical Overview", *Innovations in Electrosurgery*, 1999.
- Vallfors et al., "Automatically Controlled Bipolar Electrocoagulation—'COA-COMP'" *Neurosurgical Review* 7:2-3(1984) pp. 187-190.
- W. Scott Helton, "LigaSure™ Vessel Sealing System: Revolutionary Hemostasis Product for General Surgery" Sales/Product Literature 1999.
- Wald et al., "Accidental Burns", *JAMA*, Aug. 16, 1971, vol. 217, No. 7, pp. 916-921.
- Walt Boyles, "Instrumentation Reference Book", 2002, Butterworth-Heinemann, pp. 262-264.
- Wonnell et al., "Evaluation of Microwave and Radio Frequency Catheter Ablation in a Myocardium-Equivalent Phantom Model", *IEEE Transactions on Biomedical Engineering*, vol. 39, No. 10, Oct. 1992; pp. 1086-1095.
- European Search Report EP 98300964.8 dated Dec. 13, 2000.
- European Search Report EP 98944778 dated Nov. 7, 2000.
- European Search Report EP 98958575.7 dated Oct. 29, 2002.
- European Search Report EP 02786604.5 dated Feb. 10, 2010.
- European Search Report EP 03721482 dated Feb. 6, 2006.
- European Search Report EP 04009964 dated Jul. 28, 2004.
- European Search Report EP 04013772 dated Apr. 11, 2005.
- European Search Report EP 04015980 dated Nov. 3, 2004.
- European Search Report EP 04015981.6 dated Oct. 25, 2004.
- European Search Report EP 04027314 dated Mar. 31, 2005.
- European Search Report EP 04027479 dated Mar. 17, 2005.
- European Search Report EP 04027705 dated Feb. 10, 2005.
- European Search Report EP 04710258 dated Oct. 15, 2004.
- European Search Report EP 04752343.6 dated Jul. 31, 2007.
- European Search Report EP 04778192.7 dated Jul. 1, 2009.
- European Search Report EP 05002027.0 dated May 12, 2005.
- European Search Report EP 05002769.7 dated Jun. 19, 2006.
- European Search Report EP 05013463.4 dated Oct. 7, 2005.
- European Search Report EP 05013895 dated Oct. 21, 2005.
- European Search Report EP 05014156.3 dated Jan. 4, 2006.
- European Search Report EP 05016399 dated Jan. 13, 2006.
- European Search Report EP 05017281 dated Nov. 24, 2005.
- European Search Report EP 05019130.3 dated Oct. 27, 2005.
- European Search Report EP 05019882 dated Feb. 16, 2006.
- European Search Report EP 05020665.5 dated Feb. 27, 2006.
- European Search Report EP 05020666.3 dated Feb. 27, 2006.
- European Search Report EP 05021025.1 dated Mar. 13, 2006.
- European Search Report EP 05021197.8 dated Feb. 20, 2006.
- European Search Report EP 05021777 dated Feb. 23, 2006.
- European Search Report EP 05021779.3 dated Feb. 2, 2006.
- European Search Report EP 05021780.1 dated Feb. 23, 2006.
- European Search Report EP 05021935 dated Jan. 27, 2006.
- European Search Report EP 05021936.9 dated Feb. 6, 2006.
- European Search Report EP 05021937.7 dated Jan. 23, 2006.
- European Search Report EP 05021939 dated Jan. 27, 2006.
- European Search Report EP 05021944.3 dated Jan. 25, 2006.
- European Search Report EP 05022350.2 dated Jan. 30, 2006.
- European Search Report EP 05023017.6 dated Feb. 24, 2006.
- European Search Report EP 05025423.4 dated Jan. 19, 2007.
- European Search Report EP 05025424 dated Jan. 30, 2007.
- European Search Report EP 05810523 dated Jan. 29, 2009.
- European Search Report EP 06000708.5 dated May 15, 2006.
- European Search Report EP 06002279.5 dated Mar. 30, 2006.
- European Search Report EP 06005185.1 dated May 10, 2006.
- European Search Report EP 06005540 dated Sep. 24, 2007.
- European Search Report EP 06006717.0 dated Aug. 11, 2006.
- European Search Report EP 06006961 dated Oct. 22, 2007.
- European Search Report EP 06006963 dated Aug. 4, 2006.
- European Search Report EP 06008779.8 dated Jul. 13, 2006.
- European Search Report EP 06009435 dated Jul. 13, 2006.
- European Search Report EP 06010499.9 dated Jan. 29, 2008.
- European Search Report EP 06014461.5 dated Oct. 31, 2006.
- European Search Report EP 06018206.0 dated Oct. 20, 2006.
- European Search Report EP 06019768 dated Jan. 17, 2007.
- European Search Report EP 06020574.7 dated Oct. 13, 2007.
- European Search Report EP 06020583.8 dated Feb. 7, 2007.
- European Search Report EP 06020584.6 dated Feb. 1, 2007.
- European Search Report EP 06020756.0 dated Feb. 16, 2007.
- European Search Report EP 06022028.2 dated Feb. 13, 2007.
- European Search Report EP 06023756.7 dated Feb. 21, 2008.
- European Search Report EP 06024122.1 dated Apr. 16, 2007.
- European Search Report EP 06024123.9 dated Mar. 6, 2007.
- European Search Report EP 06025700.3 dated Apr. 12, 2007.
- European Search Report EP 07000885.9 dated May 15, 2007.
- European Search Report EP 07001480.8 dated Apr. 19, 2007.
- European Search Report EP 07001481.6 dated May 2, 2007.
- European Search Report EP 07001485.7 dated May 23, 2007.
- European Search Report EP 07001488.1 dated Jun. 5, 2007.
- European Search Report EP 07001489.9 dated Dec. 20, 2007.
- European Search Report EP 07001491 dated Jun. 6, 2007.
- European Search Report EP 07001527.6 dated May 18, 2007.
- European Search Report EP 07007783.9 dated Aug. 14, 2007.
- European Search Report EP 07008207.8 dated Sep. 13, 2007.
- European Search Report EP 07009026.1 dated Oct. 8, 2007.
- European Search Report EP 07009028 dated Jul. 16, 2007.
- European Search Report EP 07009029.5 dated Jul. 20, 2007.
- European Search Report EP 07009321.6 dated Aug. 28, 2007.
- European Search Report EP 07009322.4 dated Jan. 14, 2008.
- European Search Report EP 07010672.9 dated Oct. 16, 2007.
- European Search Report EP 07010673.7 dated Oct. 5, 2007.
- European Search Report EP 07013779.9 dated Oct. 26, 2007.
- European Search Report EP 07015191.5 dated Jan. 23, 2008.
- European Search Report EP 07015601.3 dated Jan. 4, 2008.
- European Search Report EP 07015602.1 dated Dec. 20, 2007.
- European Search Report EP 07018375.1 dated Jan. 8, 2008.
- European Search Report EP 07018821 dated Jan. 14, 2008.
- European Search Report EP 07019173.9 dated Feb. 12, 2008.
- European Search Report EP 07019174.7 dated Jan. 29, 2008.
- European Search Report EP 07019178.8 dated Feb. 12, 2008.
- European Search Report EP 07020283.3 dated Feb. 5, 2008.
- European Search Report EP 07253835.8 dated Dec. 20, 2007.
- European Search Report EP 08001019 dated Sep. 23, 2008.
- European Search Report EP 08004974.5 dated Apr. 6, 2011.
- European Search Report EP 08004975 dated Jul. 24, 2008.
- European Search Report EP 08006731.7 dated Jul. 29, 2008.
- European Search Report EP 08006733 dated Jul. 7, 2008.
- European Search Report EP 08006734.1 dated Aug. 18, 2008.
- European Search Report EP 08006735.8 dated Jan. 8, 2009.
- European Search Report EP 08007924.7 partial dated Aug. 17, 2010.
- European Search Report EP 08011282 dated Aug. 14, 2009.
- European Search Report EP 08011705 dated Aug. 20, 2009.
- European Search Report EP 08011705.4 extended dated Nov. 4, 2009.
- European Search Report EP 08012829.1 dated Oct. 29, 2008.
- European Search Report EP 08015842 dated Dec. 5, 2008.
- European Search Report EP 08019920.1 dated Mar. 27, 2009.
- European Search Report EP 08020530.5 dated May 27, 2009.
- European Search Report EP 08169973.8 dated Apr. 6, 2009.
- European Search Report EP 09010873.9 extended dated Nov. 13, 2009.
- European Search Report EP 09010877.0 extended dated Dec. 3, 2009.
- European Search Report EP 09012389.4 dated Jul. 6, 2010.

(56)

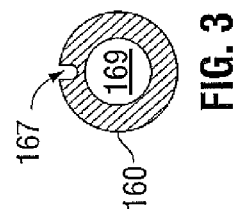
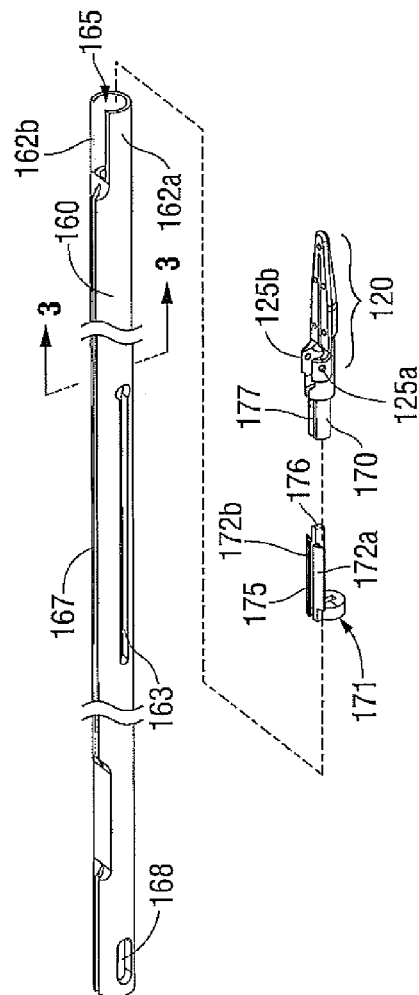
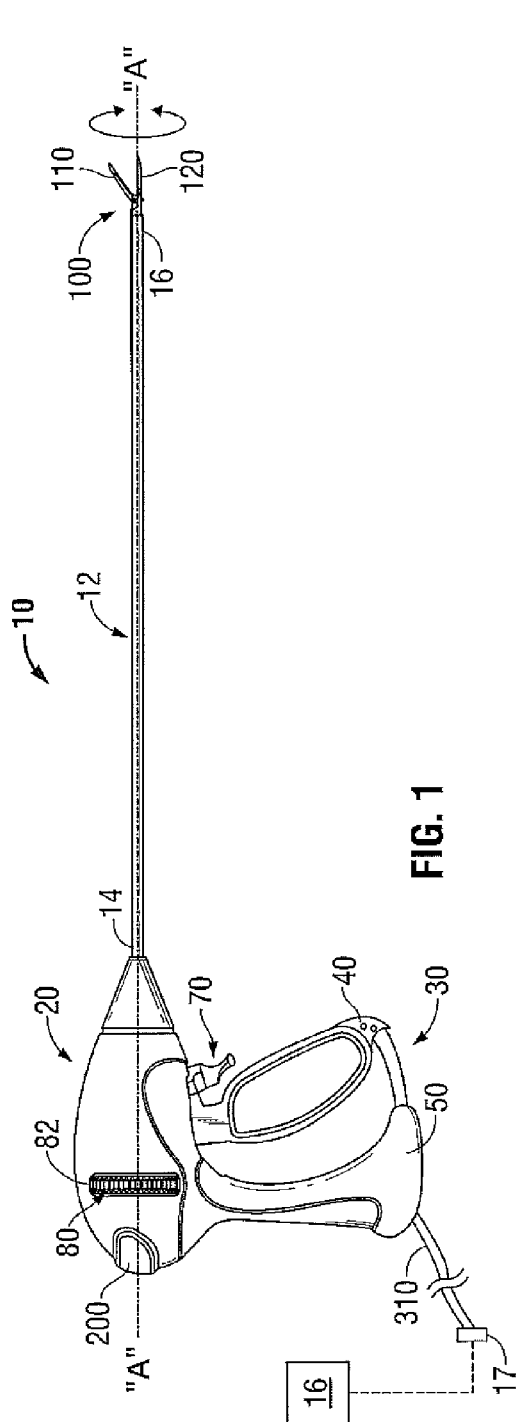
References Cited

OTHER PUBLICATIONS

European Search Report EP 09151621 dated Jun. 18, 2009.
 European Search Report EP 09156861.8 dated Aug. 4, 2009.
 European Search Report EP 09161502.1 dated Sep. 2, 2009.
 European Search Report EP 09161502.1 extended dated Oct. 30, 2009.
 European Search Report EP 09165976.3 extended dated Mar. 17, 2010.
 European Search Report EP 09166708 dated Oct. 15, 2009.
 European Search Report EP 09166708.9 dated Mar. 18, 2010.
 European Search Report EP 09169376.2 extended dated Dec. 16, 2009.
 European Search Report EP 09172188.6 extended dated Apr. 23, 2010.
 European Search Report EP 09172838.6 extended dated Jan. 20, 2010.
 European Search Report EP 09173268.5 extended dated Jan. 27, 2010.
 European Search Report EP 10001767.2 extended dated Jun. 18, 2010.
 European Search Report EP 10004950.1 extended dated Jul. 2, 2010.
 European Search Report EP 10004951.9 extended dated Jul. 2, 2010.
 European Search Report EP 10005533.4 extended dated Sep. 24, 2010.
 European Search Report EP 10005534.2 extended dated Sep. 17, 2010.
 European Search Report EP 10006373.4 extended dated Nov. 11, 2010.
 European Search Report EP 10008139.7 extended dated Nov. 30, 2010.
 European Search Report EP 10008140.5 extended dated Dec. 28, 2010.
 European Search Report EP 10008850.9 extended dated Nov. 30, 2010.
 European Search Report EP 10009731.0 extended dated Jan. 28, 2011.

European Search Report EP 10009732.8 extended dated Jan. 26, 2011.
 European Search Report EP 10010943.8 extended dated Feb. 1, 2011.
 European Search Report EP 10011750.6 extended dated Feb. 1, 2011.
 European Search Report EP 10014042.5 extended dated Feb. 18, 2011.
 European Search Report EP 10158944.8 extended dated Jun. 21, 2010.
 European Search Report EP 10161722.3 extended dated Jun. 16, 2010.
 European Search Report EP 10163235.4 dated Aug. 10, 2010.
 European Search Report EP 10185413.1 dated Dec. 7, 2010.
 European Search Report EP 10185413.1 dated Mar. 14, 2011.
 European Search Report EP 10191321.8 dated Apr. 7, 2011.
 International Search Report PCT/US97/05066 dated Jun. 24, 1997.
 International Search Report PCT/US98/18640 dated Jan. 29, 1999.
 International Search Report PCT/US98/23950 dated Jan. 14, 1999.
 International Search Report PCT/US99/24869 dated Feb. 11, 2000.
 International Search Report PCT/US01/11218 dated Aug. 14, 2001.
 International Search Report PCT/US01/11224 dated Nov. 13, 2001.
 International Search Report PCT/US01/11340 dated Aug. 16, 2001.
 International Search Report PCT/US01/11420 dated Oct. 16, 2001.
 International Search Report PCT/US02/01890 dated Jul. 25, 2002.
 International Search Report PCT/US02/11100 dated Jul. 16, 2002.
 International Search Report PCT/US03/09483 dated Aug. 13, 2003.
 International Search Report PCT/US03/22900 dated Dec. 2, 2003.
 International Search Report PCT/US03/37110 dated Jul. 25, 2005.
 International Search Report PCT/US03/37111 dated Jul. 28, 2004.
 International Search Report PCT/US03/37310 dated Aug. 13, 2004.
 International Search Report PCT/US04/04685 dated Aug. 27, 2004.
 International Search Report PCT/US04/13273 dated Dec. 15, 2004.
 International Search Report PCT/US04/15311 dated Jan. 12, 2005.
 International Search Report PCT/US05/36168 dated Aug. 28, 2006.
 International Search Report PCT/US08/052460 dated Apr. 24, 2008.
 International Search Report PCT/US09/31658 dated Mar. 11, 2009.
 International Search Report PCT/US10/032796 dated Jul. 28, 2010.

* cited by examiner



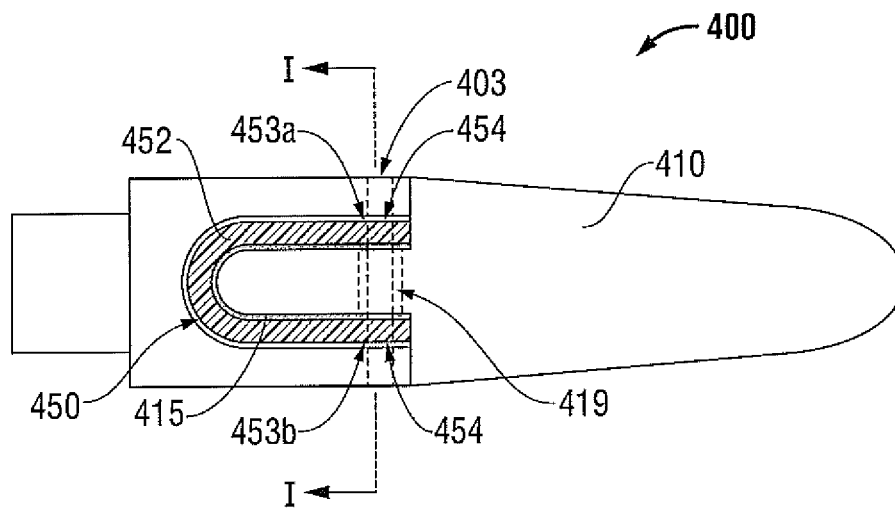


FIG. 4

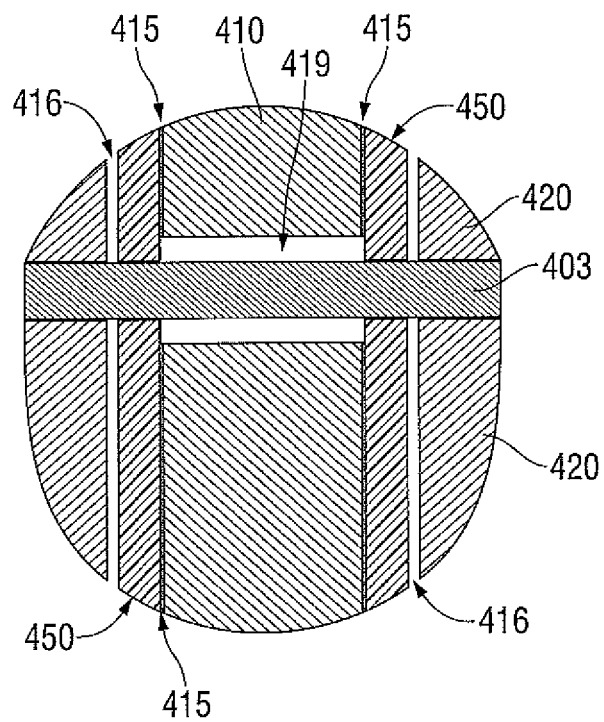


FIG. 5

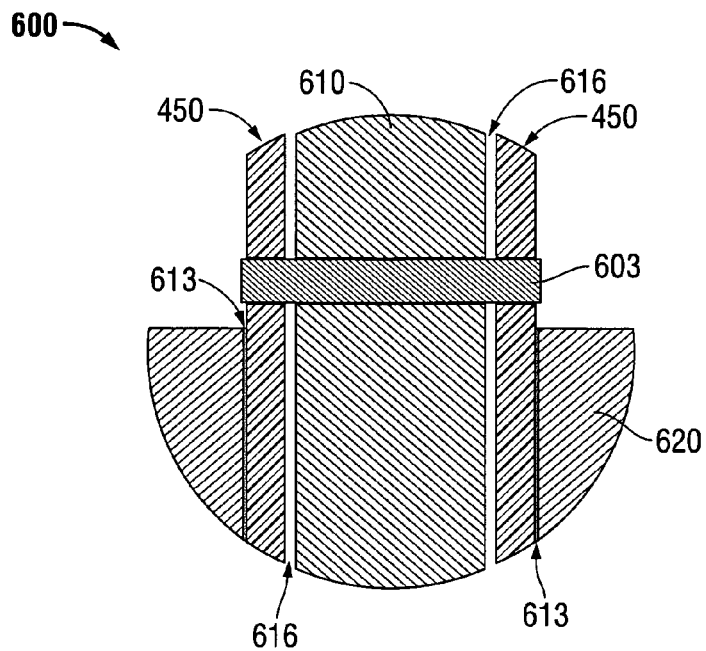


FIG. 6

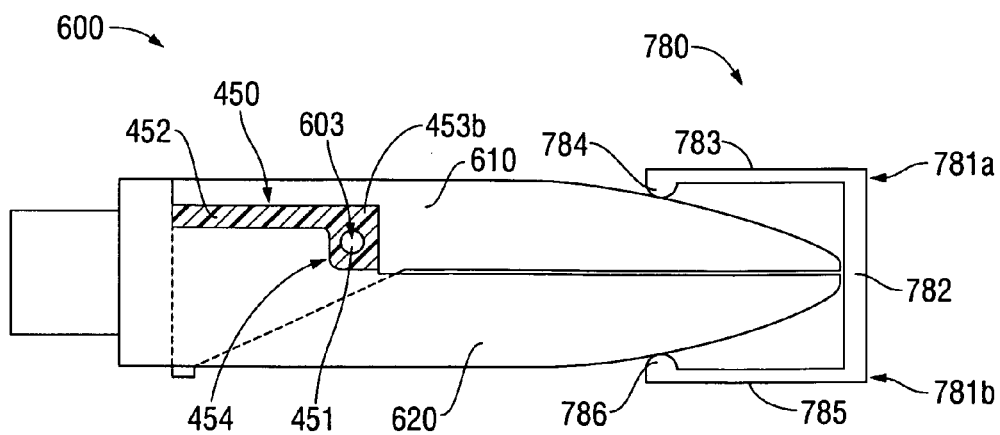


FIG. 7

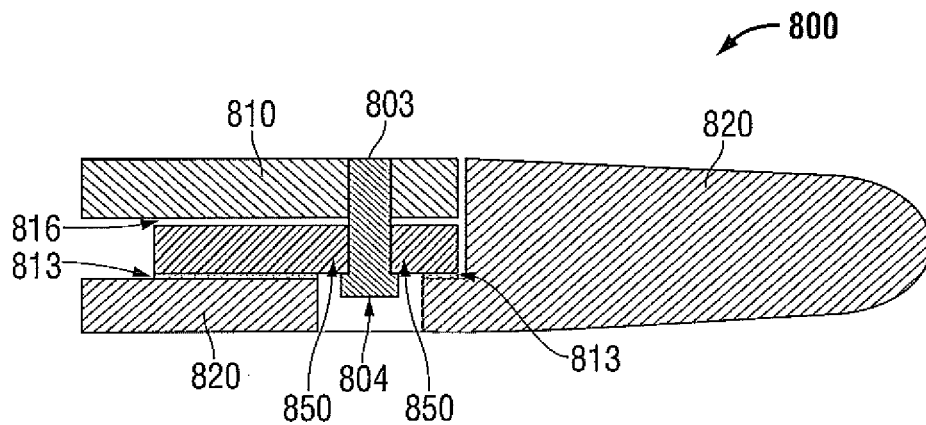


FIG. 8

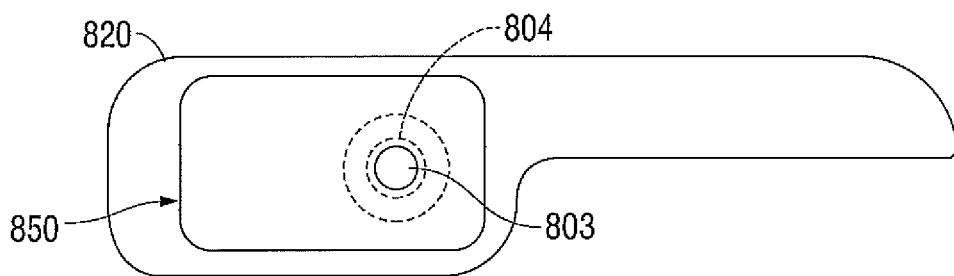


FIG. 9

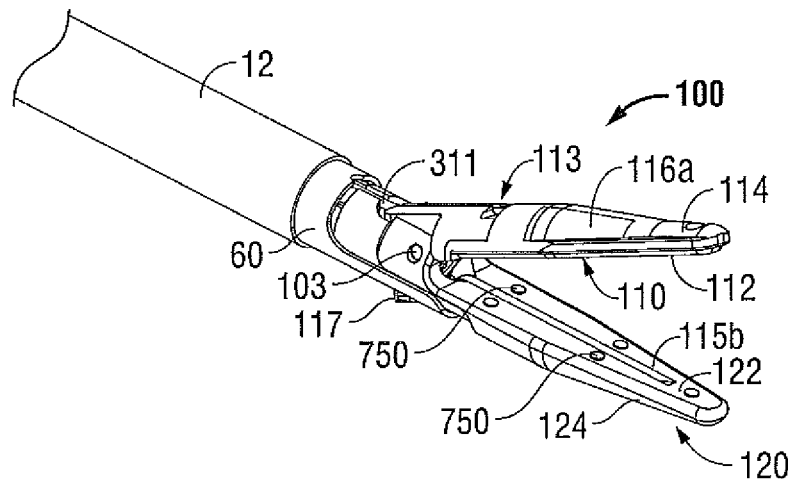


FIG. 10

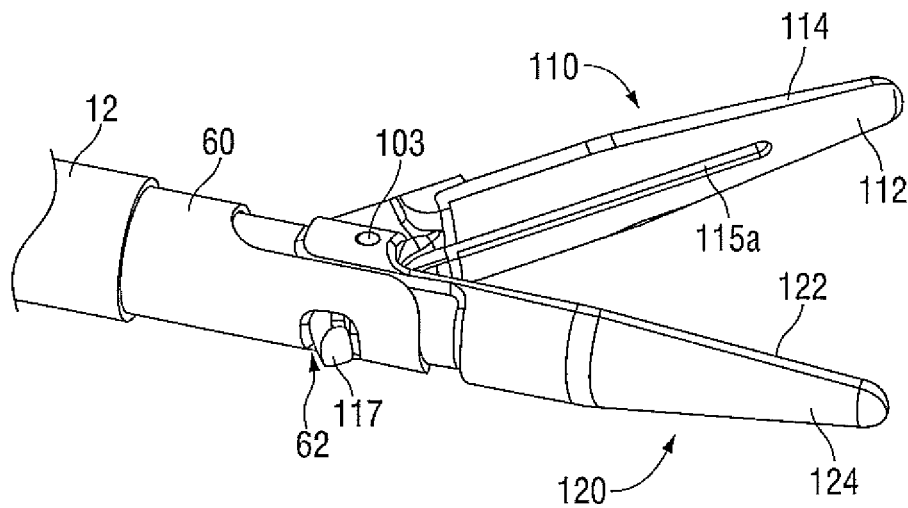


FIG. 11

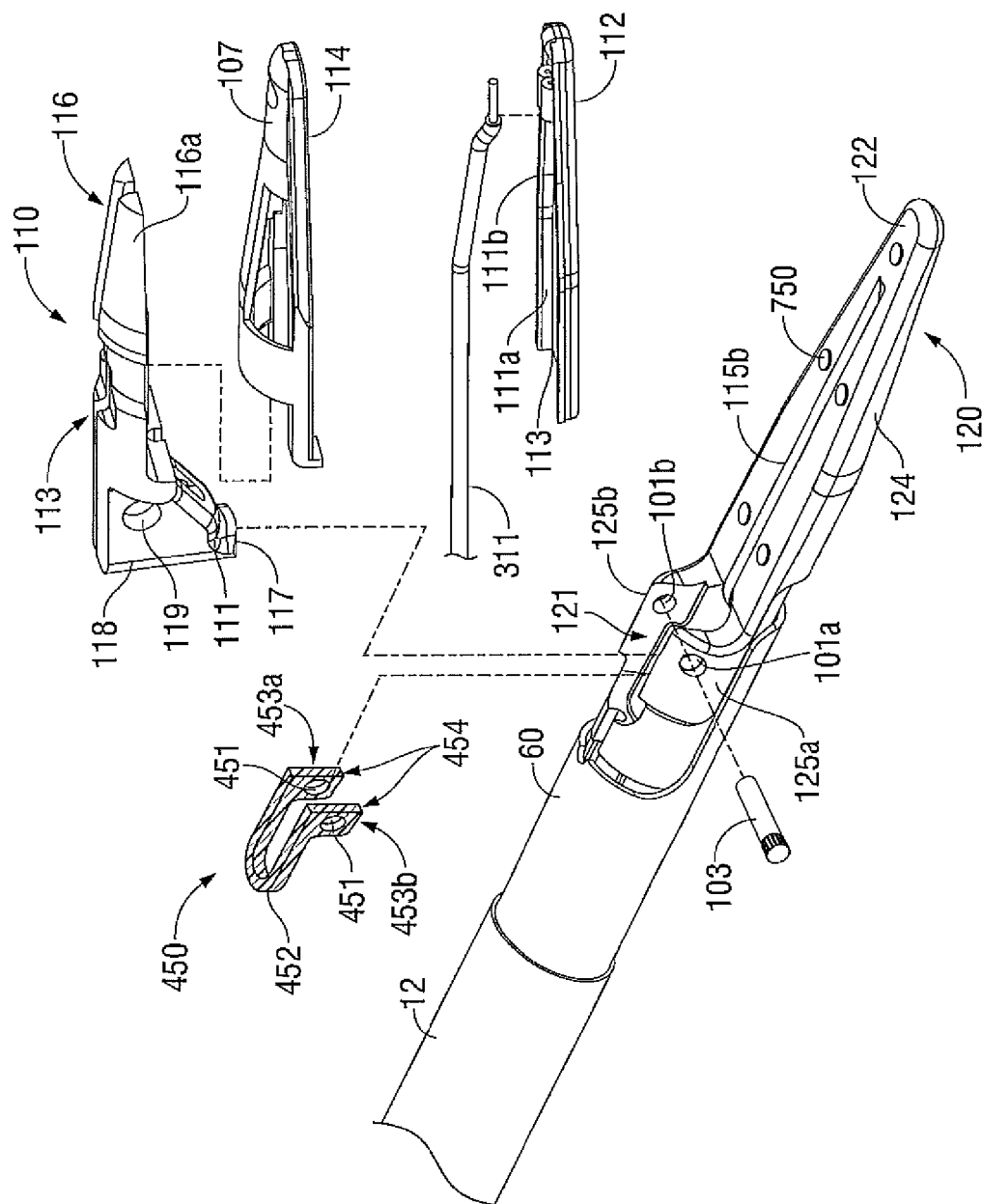


FIG. 12

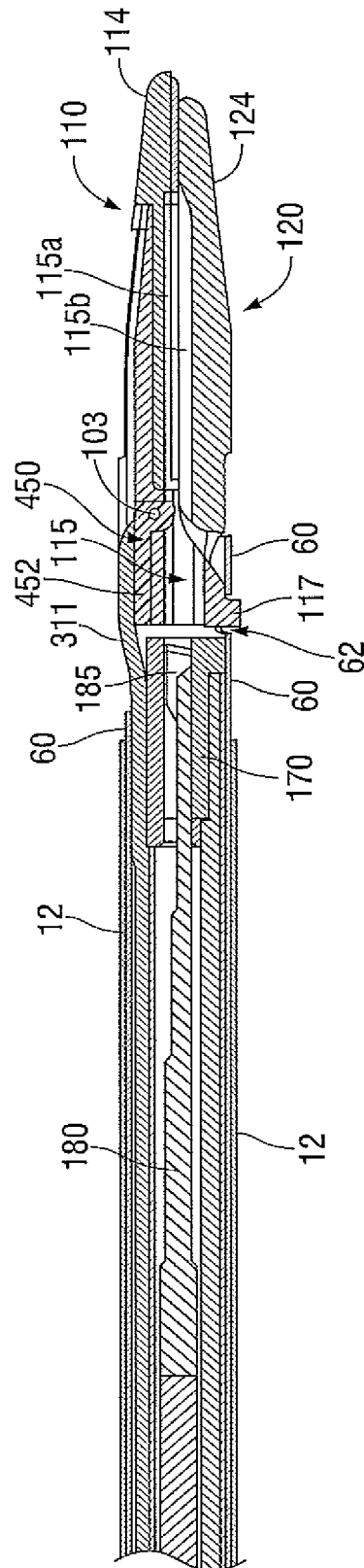


FIG. 13

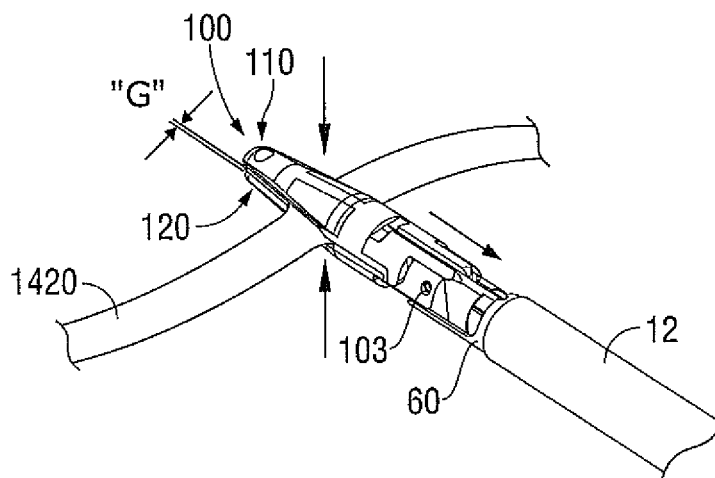


FIG. 14

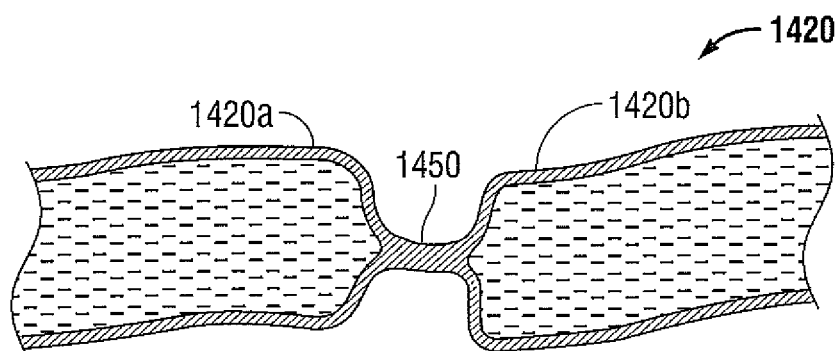


FIG. 15

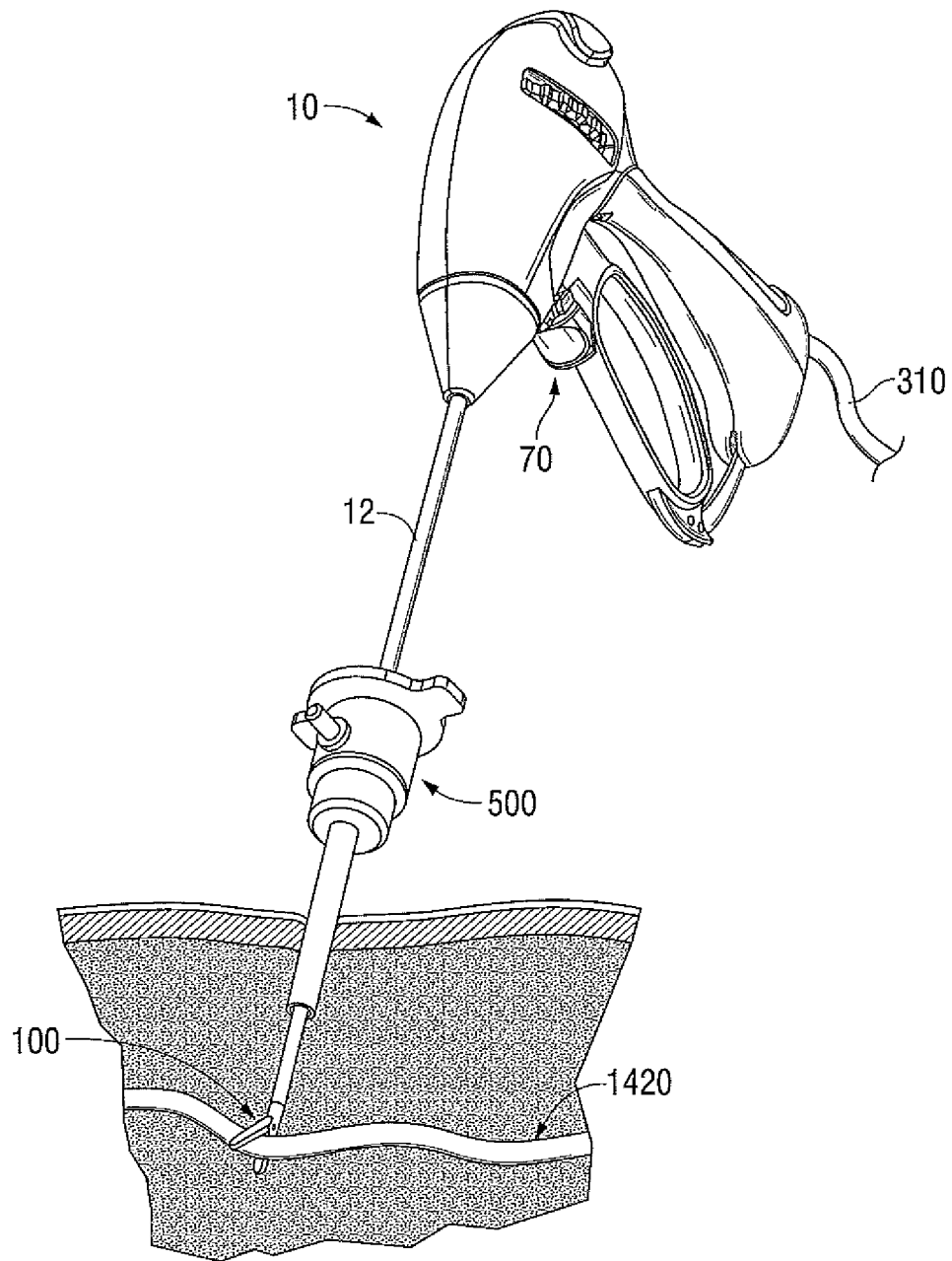
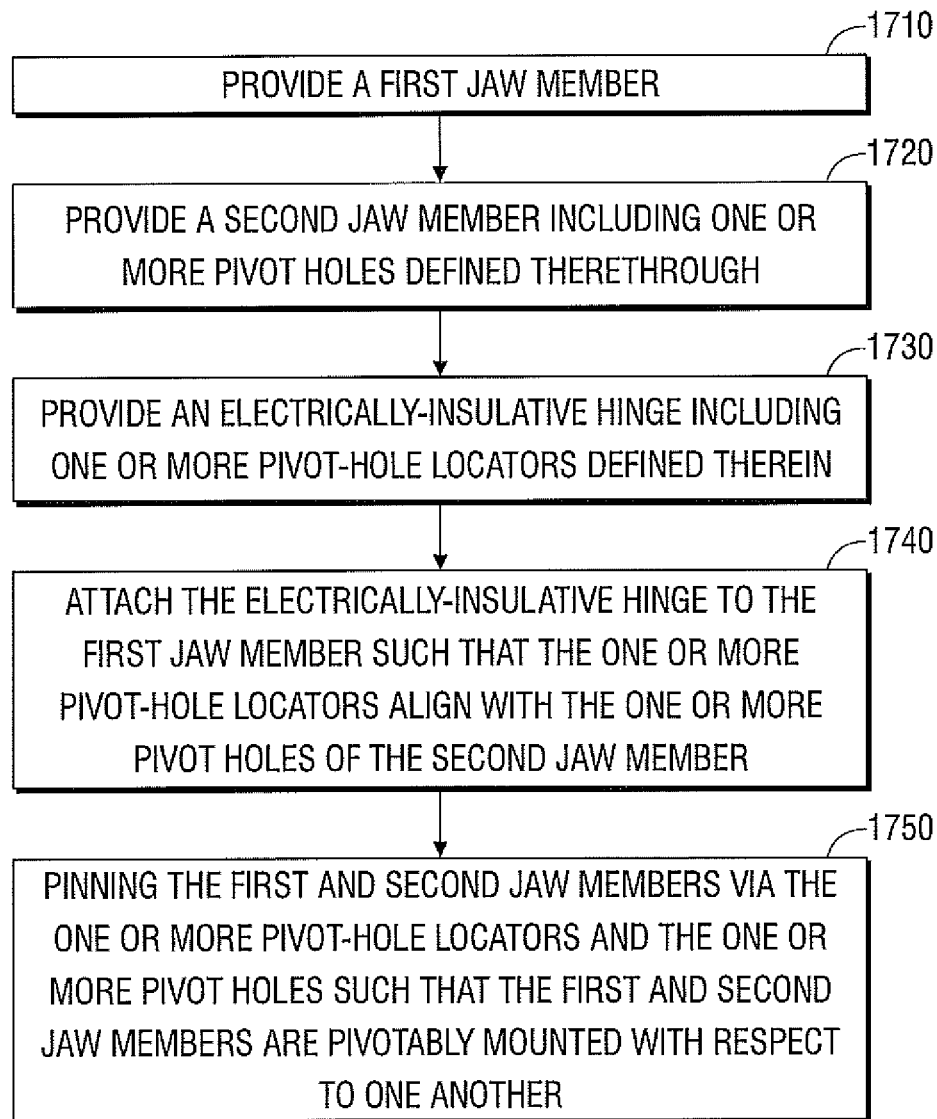


FIG. 16

**FIG. 17**

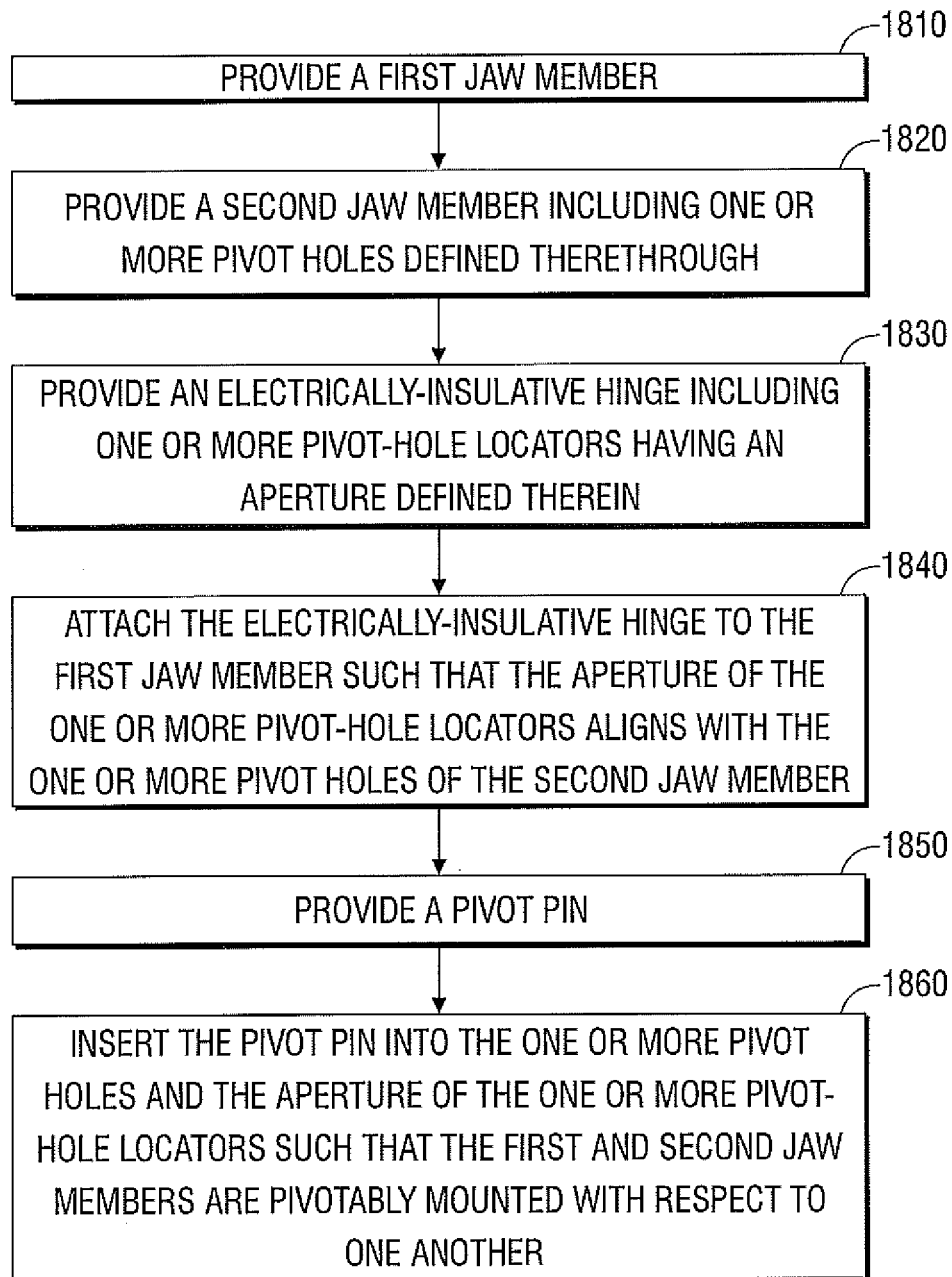


FIG. 18

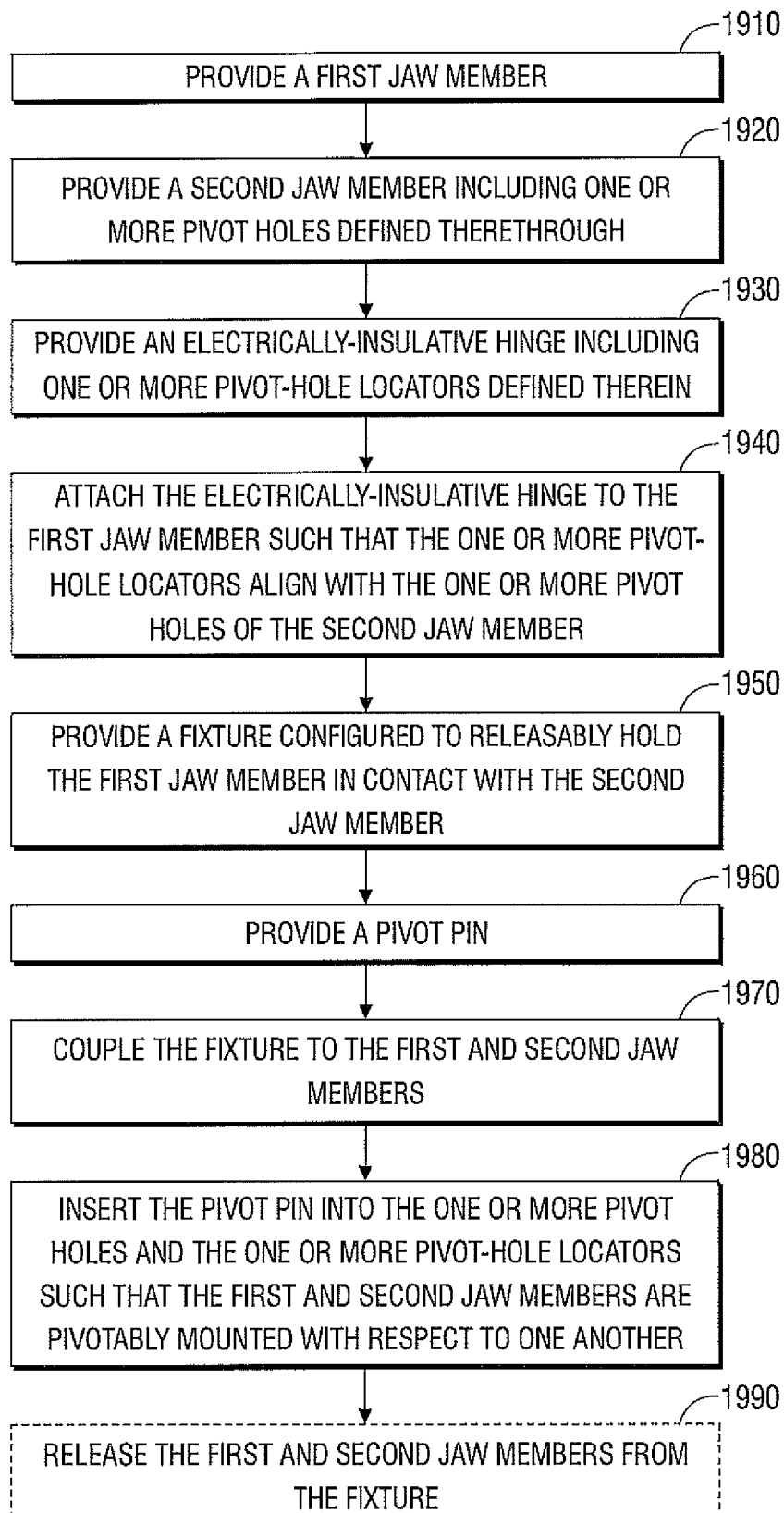


FIG. 19

1

**ELECTRICALLY-INSULATIVE HINGE FOR
ELECTROSURGICAL JAW ASSEMBLY,
BIPOLAR FORCEPS INCLUDING SAME, AND
METHODS OF JAW-ASSEMBLY ALIGNMENT
USING FASTENED
ELECTRICALLY-INSULATIVE HINGE**

BACKGROUND

1. Technical Field

The present disclosure relates to joints and hinges used to connect movable components of an electrosurgical instrument and, more particularly, to an electrically-insulative hinge for use in an electrosurgical jaw assembly, a bipolar forceps including an electrically-insulative hinge, and methods of jaw-assembly alignment using a fastened electrically-insulative hinge.

2. Discussion of Related Art

Electrosurgical instruments, such as electrosurgical forceps, have become widely used by surgeons. Electrosurgery involves application of high-frequency electrical current to a surgical site to cut, ablate, coagulate, cauterize or seal tissue.

The basic purpose of both monopolar and bipolar electrosurgery is to produce heat to achieve the desired tissue/clinical effect. In monopolar electrosurgery, devices use an instrument with a single, active electrode to deliver energy from an electrosurgical generator to tissue, and a patient return electrode or pad that is attached externally to the patient (e.g., a plate positioned on the patient's thigh or back) as the means to complete the electrical circuit between the electrosurgical generator and the patient. When the electrosurgical energy is applied, the energy travels from the active electrode, to the surgical site, through the patient and to the return electrode.

In bipolar electrosurgery, the electrosurgical device includes two electrodes that are located in proximity to one another for the application of current between their surfaces. Bipolar electrosurgical current travels from one electrode, through the intervening tissue to the other electrode to complete the electrical circuit. Bipolar instruments generally include end effectors, such as grippers, cutters, forceps, dissectors and the like.

Bipolar electrosurgical forceps utilize two generally opposing electrodes that are operably associated with the inner opposing surfaces of end effectors and that are both electrically coupled to an electrosurgical generator. Each electrode is charged to a different electric potential. By utilizing an electrosurgical forceps, a surgeon can utilize both clamping action and electrosurgical energy to cauterize, coagulate/desiccate and/or cut tissue and/or simply reduce or slow bleeding by controlling the intensity, frequency and duration of the electrosurgical energy applied to the tissue.

Typically, joints and hinges for use in electrosurgical instruments to connect movable components are formed from an electrically-insulative material to prevent electrical shorting between component parts and/or prevent the formation of alternate current paths through the instrument. As such, instrument designers have manufactured electrosurgical instruments that involve complex, rotating hinge configurations to isolate, insulate and/or control the electrosurgical active areas of the instrument.

Traditional metal hinge configurations generally include multiple, independent sub-assemblies. Typically, the sub-assemblies are overmolded with plastic material having high bond strength. These separately overmolded sub-assemblies are mechanically integrated and arranged in a series of manufacturing steps that often require tightly controlled, time-consuming processes to achieve proper jaw alignment. Addi-

2

tional steps are often undertaken to control other parameters associated with the rotational movement about the hinge, e.g., friction, torque, etc.

SUMMARY

A continuing need exists for a simple and effective electrically-insulative hinge that can be readily integrated into the manufacturing process to electrically isolate the movable components of an electrosurgical instrument. Further need exists for the development of a manufacturing process that effectively fabricates an electrosurgical instrument including an electrically-insulative hinge that electrically isolates and structurally integrates the electrically-active components of the instrument and results in the formation of a reliable instrument that meets specific tolerance requirements for proper jaw alignment and/or gap distances.

The present disclosure relates to an end effector assembly suitable for use with a forceps. The end effector assembly includes opposing first and second jaw members pivotably mounted with respect to one another. The first jaw member includes one or more pivot holes defined therein configured to receive a portion of a pivot pin therein. The end effector assembly also includes an electrically-insulative hinge configured to electrically isolate the first and second jaw members from one another including one or more pivot-hole locators defined therein. The electrically-insulative hinge is attached to the second jaw member such that the one or more pivot-hole locators aligns with the one or more pivot holes defined in the first jaw member.

The present disclosure also relates to a bipolar forceps including a housing, a shaft extending from the housing and including a distal end configured to support an end effector assembly. The end effector assembly includes opposing jaw members pivotably mounted with respect to one another, each of the jaw members including a sealing surface associated therewith. The jaw members are moveable from a first position in spaced relation relative to one another to one or more subsequent positions wherein the sealing surfaces cooperate to grasp tissue therebetween. The end effector assembly also includes an electrically-insulative hinge configured to electrically isolate the jaw members from one another including one or more pivot-hole locators each having an aperture defined therein. The electrically-insulative hinge is attached to one of the jaw members such that the aperture of each of the one or more pivot-hole locators aligns with a pivot hole defined in the opposing jaw member, wherein the electrically-insulative hinge is configured to electrically isolate the jaw members from one another.

The present disclosure also relates to a method of manufacturing an end effector assembly including the initial steps of providing a first jaw member and providing a second jaw member including one or more pivot holes defined there-through. The method also includes the steps of providing an electrically-insulative hinge including one or more pivot-hole locators defined therein, attaching the electrically-insulative hinge to the first jaw member such that the one or more pivot-hole locators align with the one or more pivot holes of the second jaw member, and pinning the first and second jaw members via the one or more pivot-hole locators and the one or more pivot holes such that the first and second jaw members are pivotably mounted with respect to one another.

The present disclosure also relates to a method of manufacturing an end effector assembly including the initial steps of providing a first jaw member including a first pivot hole defined therethrough and providing a second jaw member including a second pivot hole defined therethrough. The

3

method also includes the steps of providing an electrically-insulative hinge including at least one pivot-hole locator defined therein, attaching the electrically-insulative hinge to the first jaw member such that the at least one pivot-hole locator aligns with the first pivot hole, providing a fixture configured to releaseably hold the first jaw member in contact with the second jaw member, providing a pivot pin, coupling the fixture to the first and second jaw members, and inserting the pivot pin through the at least one pivot-hole locator into the first and second pivot holes such that the first and second jaw members are pivotably mounted with respect to one another.

BRIEF DESCRIPTION OF THE DRAWINGS

Objects and features of the presently-disclosed electrically-insulative hinge for use in an electrosurgical jaw assembly, a bipolar forceps including an electrically-insulative hinge, and methods of jaw-assembly alignment using a fastened electrically-insulative hinge will become apparent to those of ordinary skill in the art when descriptions of various embodiments thereof are read with reference to the accompanying drawings, of which:

FIG. 1 is a left, side view of an endoscopic bipolar forceps showing a housing, a rotatable member, a shaft and an end effector assembly according to an embodiment of the present disclosure;

FIG. 2 is an enlarged, perspective view of the shaft and lower jaw member of the forceps shown in FIG. 1 with parts separated according to an embodiment of the present disclosure;

FIG. 3 is an enlarged, cross-sectional view of the indicated area of detail of FIG. 2 according to an embodiment of the present disclosure;

FIG. 4 is a schematic diagram of the end effector assembly with an electrically-insulative hinge according to an embodiment of the present disclosure;

FIG. 5 is a cross-sectional view taken along the lines "I-I" of FIG. 4 illustrating the jaw members, pivot pin and electrically-insulative hinge according to an embodiment of the present disclosure;

FIG. 6 is a cross-sectional view illustrating another embodiment of an end effector assembly including the electrically-insulative hinge of FIG. 4 in accordance with the present disclosure;

FIG. 7 is a schematic diagram showing a fixture for releaseably holding the end effector assembly of FIG. 6, such as during a fastening process, according to an embodiment of the present disclosure;

FIG. 8 is a schematic diagram of an embodiment of a bilateral end effector assembly with an electrically-insulative hinge in accordance with the present disclosure;

FIG. 9 is a side-view schematic diagram of the end effector assembly of FIG. 8 illustrating the upper jaw member, pivot pin and electrically-insulative hinge according to an embodiment of the present disclosure;

FIG. 10 is an enlarged, left perspective view of the end effector assembly of FIG. 1 shown with the jaw members in an open configuration according to an embodiment of the present disclosure;

FIG. 11 is an enlarged, bottom, left perspective view of the end effector assembly of FIG. 10 according to an embodiment of the present disclosure;

FIG. 12 is an enlarged, top, left perspective view of the end effector assembly of FIG. 1 with parts separated according to an embodiment of the present disclosure;

4

FIG. 13 is an enlarged, cross-sectional view of a portion of the forceps shown in FIG. 1 according to an embodiment of the present disclosure;

FIG. 14 is an enlarged, rear perspective view of the end effector assembly of FIG. 1 shown grasping tissue;

FIG. 15 is an enlarged, cross-sectional view of a tissue seal;

FIG. 16 is a perspective view showing the forceps of the present disclosure utilized with a cannula;

FIG. 17 is a flowchart illustrating a method of manufacturing an end effector assembly according to an embodiment of the present disclosure;

FIG. 18 is a flowchart illustrating a method of manufacturing an end effector assembly according to another embodiment of the present disclosure; and

FIG. 19 is a flowchart illustrating a method of manufacturing an end effector assembly according to yet another embodiment of the present disclosure.

DETAILED DESCRIPTION

Hereinafter, embodiments of an electrically-insulative hinge for use in an electrosurgical jaw assembly, a bipolar forceps including an electrically-insulative hinge, and methods of jaw-assembly alignment using a fastened electrically-insulative hinge of the present disclosure are described with reference to the accompanying drawings. Like reference numerals may refer to similar or identical elements throughout the description of the figures. As shown in the drawings and as used in this description, and as is traditional when referring to relative positioning on an object, the term "proximal" refers to that portion of the apparatus, or component thereof, closer to the user and the term "distal" refers to that portion of the apparatus, or component thereof, farther from the user.

This description may use the phrases "in an embodiment," "in embodiments," "in some embodiments," or "in other embodiments," which may each refer to one or more of the same or different embodiments in accordance with the present disclosure. For the purposes of this description, a phrase in the form "A/B" means A or B. For the purposes of the description, a phrase in the form "A and/or B" means "(A), (B), or (A and B)". For the purposes of this description, a phrase in the form "at least one of A, B, or C" means "(A), (B), (C), (A and B), (A and C), (B and C), or (A, B and C)".

Electromagnetic energy is generally classified by increasing energy or decreasing wavelength into radio waves, microwaves, infrared, visible light, ultraviolet, X-rays and gamma-rays. As it is used in this description, "microwave" generally refers to electromagnetic waves in the frequency range of 300 megahertz (MHz) (3×10^8 cycles/second) to 300 gigahertz (GHz) (3×10^{11} cycles/second). As it is used in this description, "ablation procedure" generally refers to any ablation procedure, such as, for example, microwave ablation, radiofrequency (RF) ablation, or microwave or RF ablation-assisted resection. As it is used in this description, "transmission line" generally refers to any transmission medium that can be used for the propagation of signals from one point to another.

Various embodiments of the present disclosure provide a bipolar forceps with an end effector assembly including opposing jaw members pivotably mounted with respect to one another, and an electrically-insulative hinge fastened to one of the jaw members, wherein the electrically-insulative hinge is configured to electrically isolate the jaw members from one another. Various embodiments of the present disclosure provide methods of manufacturing an end effector assembly including the presently-disclosed electrically-insulative hinge.

5

Embodiments of the presently-disclosed bipolar forceps may be suitable for utilization in endoscopic surgical procedures, such as shown in FIG. 16, and/or suitable for utilization in open surgical applications. Embodiments of the presently-disclosed bipolar forceps may be implemented using electromagnetic radiation at microwave frequencies, RF frequencies or at other frequencies. An electrosurgical system including the presently-disclosed endoscopic bipolar forceps operatively coupled to an electrosurgical energy source (e.g., 16 shown in FIG. 1) according to various embodiments is designed and configured to operate at frequencies between about 300 KHz and about 10 GHz.

Although the following description describes the use of an endoscopic bipolar forceps, the teachings of the present disclosure may also apply to a variety of electrosurgical devices that include hinges used to connect movable components thereof.

In FIG. 1, an embodiment of an endoscopic bipolar forceps 10 is shown for use with various surgical procedures and generally includes a housing 20, a handle assembly 30, a rotatable assembly 80, a trigger assembly 70 and an end effector assembly 100 that mutually cooperate to grasp, seal and/or divide tubular vessels and vascular tissue (e.g., 1420 shown in FIGS. 14 through 16). Although FIG. 1 depicts a bipolar forceps 10 for use in connection with endoscopic surgical procedures, the teachings of the present disclosure may also apply to more traditional open surgical procedures. For the purposes herein, the forceps 10 is described in terms of an endoscopic instrument; however, it is contemplated that an open version of the forceps may also include the same or similar operating components and features as described below.

Forceps 10 includes a shaft 12 that has a distal end 16 configured to mechanically engage the end effector assembly 100 and a proximal end 14 configured to mechanically engage the housing 20. In some embodiments, the shaft 12 has a length from a proximal side of the handle assembly 30 to a distal side of the forceps 10 in a range of about 7 centimeters to about 44 centimeters.

Details of how the shaft 12 connects to the end effector assembly 100 are described in more detail below with respect to FIG. 2. The proximal end 14 of the shaft 12 is received within the housing 20, and connections relating thereto are disclosed in commonly assigned U.S. Pat. No. 7,150,097 entitled "METHOD OF MANUFACTURING JAW ASSEMBLY FOR VESSEL SEALER AND DIVIDER", commonly assigned U.S. Pat. No. 7,156,846 entitled "VESSEL SEALER AND DIVIDER FOR USE WITH SMALL TROCARS AND CANNULAS", commonly assigned U.S. Pat. No. 7,597,693 entitled "VESSEL SEALER AND DIVIDER FOR USE WITH SMALL TROCARS AND CANNULAS" and commonly assigned U.S. Pat. No. 7,771,425 entitled "VESSEL SEALER AND DIVIDER HAVING A VARIABLE JAW CLAMPING MECHANISM".

Forceps 10 includes an electrosurgical cable 310. Electrosurgical cable 310 may be formed from a suitable flexible, semi-rigid or rigid cable, and may connect directly to an electrosurgical power generating source 16, e.g., a microwave or RF electrosurgical generator. In some embodiments, the electrosurgical cable 310 connects the forceps 10 to a connector 17, which further operably connects the instrument 10 to the electrosurgical power generating source 16. Electrosurgical cable 310 may be internally divided into one or more cable leads (e.g., 311 shown in FIG. 12) each of which transmits electrosurgical energy through their respective feed paths to the end effector assembly 100.

6

Electrosurgical power generating source 16 may be any generator suitable for use with electrosurgical devices, and may be configured to provide various frequencies of electromagnetic energy. Examples of electrosurgical generators that may be suitable for use as a source of electrosurgical energy are commercially available under the trademarks FORCE EZ™, FORCE FX™, SURGISTAT™ II, and FORCE TRIAD™ offered by Covidien. Electrosurgical cable 310 may additionally, or alternatively, provide a conduit (not shown) configured to provide coolant fluid from a coolant source (not shown) to one or more components of the forceps 10. Forceps 10 may alternatively be configured as a wireless device or battery-powered.

End effector assembly 100 may be selectively and releaseably engageable with the distal end 16 of the shaft 12, and/or the proximal end 14 of the shaft 12 may be selectively and releaseably engageable with the housing 20 and the handle assembly 30. In either of these two instances, the forceps 10 would be considered "partially disposable" or "reposable", e.g., a new or different end effector assembly 100 (or end effector assembly 100 and shaft 12) selectively replaces the old end effector assembly 100 as needed. As can be appreciated, some of the presently-disclosed electrical and/or mechanical connections may have to be altered to modify the instrument to a reposable forceps.

End effector assembly 100 generally includes a pair of opposing jaw members 110 and 120 pivotably mounted with respect to one another. End effector assembly 100 includes an electrically-insulative hinge 450 (shown in FIGS. 12 and 13), which is described in more detail later in this disclosure, configured to electrically isolate the jaw members from one another. Electrically-insulative hinge 450 can be used to align the jaw members 110 and 120 during assembly of the end effector assembly 100, such as shown in FIG. 7. End effector assembly 100 is designed as a unilateral assembly, i.e., the end effector assembly 100 includes a stationary or fixed jaw member 120 mounted in fixed relation to the shaft 12 and a pivoting jaw member 110 mounted about a pivot pin 103 (shown in FIGS. 10 through 13) coupled to the stationary jaw member 120. Alternatively, the forceps 10 may include a bilateral jaw assembly, i.e., both jaw members move relative to one another. A reciprocating sleeve 60 (shown in FIGS. 11 through 14) is slidably disposed within the shaft 12. Pulling the sleeve 60 proximally closes the jaw members 110 and 120 about tissue grasped therebetween, and pushing the sleeve 60 distally opens the jaw members 110 and 120. Sleeve 60 is remotely operable by a drive assembly (not shown).

As shown in FIGS. 10 through 13, the pivoting jaw member 110 includes a detent or protrusion 117 that extends from the pivoting jaw member 110 through an aperture 62 (FIGS. 11 and 13) disposed within the reciprocating sleeve 60. As best shown in FIG. 11, the protrusion 117 is configured to matingly engage the aperture 62 of sleeve 60 upon retraction thereof. Pivoting jaw member 110 is actuated by sliding the reciprocating sleeve 60 axially within the shaft 12 such that a distal end of the aperture 62 abuts against the detent 117 on the pivoting jaw member 110. For example, proximal movement of the sleeve 60 engages detent 117 to pivot the jaw member 110 to a closed position for grasping purposes.

As shown in FIG. 1, the end effector assembly 100 is rotatable about a longitudinal axis "A-A" through rotation, either manually or otherwise, of the rotatable assembly 80. Rotatable assembly 80 generally includes two halves (not shown), which, when assembled about tube 160 (FIGS. 2 and 3), form a generally circular rotatable member 82. Rotatable assembly 80, or portions thereof, may be configured to house a drive assembly (not shown) and/or a knife assembly 180

(shown in FIG. 13), or components thereof. Examples of rotatable assembly embodiments, drive assembly embodiments, and knife assembly embodiments of the forceps 10 are described in the above-mentioned, commonly-assigned U.S. Pat. Nos. 7,150,097, 7,156,846, 7,597,693 and 7,771,425.

Handle assembly 30 includes a fixed handle 50 and a movable handle 40. In some embodiments, the fixed handle 50 is integrally associated with the housing 20, and the handle 40 is selectively movable relative to the fixed handle 50. Movable handle 40 of the handle assembly 30 is ultimately connected to the drive assembly (not shown) and mechanically cooperate to impart movement of the jaw members 110 and 120 from an open position, wherein the jaw members 110 and 120 are disposed in spaced relation relative to one another, to a clamping or closed position, wherein the jaw members 110 and 120 cooperate to grasp tissue (e.g., 1420 shown in FIG. 14) therebetween. Examples of handle assembly embodiments of the forceps 10 are described in the above-mentioned, commonly-assigned U.S. Pat. Nos. 7,150,097, 7,156,846, 7,597,693 and 7,771,425.

Forceps 10 includes a switch 200 configured to permit the user to selectively activate the forceps 10 in a variety of different orientations, i.e., multi-oriented activation. As can be appreciated, this simplifies activation. When the switch 200 is depressed, electrosurgical energy is transferred through one or more leads (e.g., 311 shown in FIGS. 10, 12 and 13) to the jaw members 110 and 120. Switch 200 may be disposed on another part of the forceps 10 (e.g., the fixed handle 50, rotatable member 82, etc.) or another location on the housing assembly 20.

FIG. 4 shows a schematic of an end effector assembly 400 that includes an electrically-insulative hinge 450 according to an embodiment of the present disclosure. End effector assembly 400 (also referred to herein as a "jaw assembly") generally includes a pair of opposing jaw members 410 and 420. Jaw members 410 and 420 are pivotably mounted with respect to one another such that jaw member 410 pivots in a unilateral fashion from an open position to a closed position for grasping and manipulating tissue. Jaw members 410 and 420 shown in FIG. 4 are similar to the jaw members 110 and 120 of FIG. 1, respectively, and further description thereof is omitted in the interests of brevity.

As best shown in FIG. 7, the electrically-insulative hinge 450 is configured with one or more pivot-hole locators 454 to facilitate proper alignment of the jaw members 410 and 420 during assembly of the end effector assembly 400. Electrically-insulative hinge 450 is configured to electrically isolate the jaw members 410 and 420 from one another, and may be bonded or otherwise securely attached to either one of the jaw members. Electrically-insulative hinge 450 may be attached to the moveable jaw member 410 or the fixed jaw member 420 using any suitable material or bonding process.

In the embodiment shown in FIGS. 4 and 5, the electrically-insulative hinge 450 is attached to the moveable jaw member 410, e.g., using an adhesive material 415. Alternatively, the electrically-insulative hinge 450 may be attached to the fixed jaw member (e.g., 620, as shown in FIG. 6). In some embodiments, as shown in FIG. 5, the fixed jaw member 420 and the electrically-insulative hinge 450 affixed to the moveable jaw member 410 are spaced apart by a gap 416, e.g., to reduce friction and/or wear.

During use of the jaw assembly 400, the electrically-insulative hinge 450 maintains electrical isolation of the jaw members 410 and 420, permitting energy potential to flow through the tissue being treated before returning through the opposing jaw. For example, when the jaw members 410 and 420 are electrically isolated from one another, electrosurgical

energy can be effectively transferred through tissue 1420 to form seal 1450 as shown in FIG. 15.

In the embodiment shown in FIGS. 4 and 5, the unilateral jaw assembly 400 includes the electrically-insulative hinge 450 and a pivot pin 403 connecting the jaw members 410 and 420 at their rotation point, allowing the movable jaw member 410 to rotate relative to the fixed jaw member 420. As cooperatively shown in FIGS. 4 and 5, the pivot pin 403 passes through the pin slot or opening 419 defined in the moveable jaw member 410 and is received by the pivot holes defined in the fixed jaw member 420 (e.g., similar to the pivot holes 101a, 101b defined in the fixed jaw member 120 shown in FIG. 12) and the apertures 451 (FIG. 12) defined in the pivot-hole locators 454 of the electrically-insulative hinge 450 such that the jaw members 410 and 420 are pivotably mounted with respect to one another. Alternatively, wherein both jaw members are movable, a bilateral end effector assembly (e.g., bilateral end effector assembly 800 shown in FIG. 8) includes an electrically-insulative hinge (e.g., 850 shown in FIG. 8) configured to provide electrical isolation of the jaw members.

As shown in FIGS. 5, 6 and 8, the presently-disclosed jaw assemblies and electrically-insulative hinge embodiments allow a pivot pin (e.g., 403 shown in FIG. 5, 603 shown in FIGS. 6, and 803 shown in FIG. 8) to be connected to one jaw member (e.g., 420 shown in FIG. 5, 610 shown in FIG. 6, and 810 shown in FIG. 8) and to the electrically-insulative hinge (e.g., 450 shown in FIGS. 5 and 6, and 850 shown in FIG. 8) that is bonded or otherwise attached to the opposing jaw member. In either unilateral or bilateral end effector embodiments, by connecting the pivot pin, which may be formed of an electrically-conductive material, to one jaw member and not to the other jaw member but, instead, to the electrically-insulative hinge, the pivot pin will not defeat the electrical isolation of the jaw members.

As cooperatively shown in FIGS. 4 and 7, electrically-insulative hinge 450 includes a generally U-shaped body member 452 and two end portions 453a and 453b disposed at the opposite ends of the body member 452. The shape and size of the body member 452 and end portions 453a and 453b, which are described in more detail below, may be varied from the configuration depicted in FIGS. 4 through 7.

Electrically-insulative hinge 450 is configured with one or more pivot-hole locators 454, e.g., defined by the end portions 453a and/or 453b. In some embodiments, each of the end portions 453a and 453b includes an aperture 451 defined therein. Alternatively, only one of the end portions 453a or 453b includes an aperture 451 defined therein. Aperture 451 is configured to receive a portion of a pivot pin 403 therein. Electrically-insulative hinge 450 is formed from a suitable electrically-insulative material. Examples of electrically-insulative materials that may be suitable for forming the electrically-insulative hinge 450 include without limitation plastics, ceramic, glass or other non-conductive materials with desired properties. Electrically-insulative hinge 450 may be fastened to either one of the jaws by any suitable process including without limitation adhesive bonding, soldering, brazing, overmolding, mechanical interlock, snaps, bent tabs, screws or other mechanical fasteners, etc.

FIG. 6 shows a unilateral jaw assembly 600 that includes the electrically-insulative hinge 450, a pivot pin 603, and jaw members 610 and 620. In the embodiment shown in FIG. 6, the electrically-insulative hinge 450 is attached to the fixed jaw member 620, e.g., using an adhesive material 613. In some embodiments, the moveable jaw member 610 and the electrically-insulative hinge 450 that is attached to the fixed jaw member 620 are spaced apart by a gap 616, e.g., to reduce friction and/or wear.

FIG. 7 shows a schematic of a fixture **780** configured to releaseably hold the end effector assembly **600** of FIG. 6, such as during a fastening process, according to an embodiment of the present disclosure. Fixture **780** is configured to hold the jaw members **610** and **620** in proper alignment while the electrically-insulative hinge **450** is fastened and/or cured to the moveable jaw member **610** or the fixed jaw member **620**. In some embodiments, the jaw members **610** and **620** are self-aligned by pre-assembling the jaw components including the jaw members **610** and **620**, the electrically-insulative hinge **450** and the pivot pin **603**. Any remaining degrees of freedom are then constrained by the holding fixture **780** until the bond between the electrically-insulative hinge **450** and the fixed jaw member **620** (shown in FIG. 6) or the bond between the electrically-insulative hinge **450** and the moveable jaw member **610** is completed. In the embodiment shown in FIG. 7, the fixture **780** serves to hold the sealing surface of the jaw member **610** directly against the sealing surface of the jaw member **620** with desired jaw gap controlled by gap features on the jaw members **610**, **620** and/or with shims used during assembly, which may be a critical alignment, while the bond is made. When the bonding process is completed, the holding fixture **780** may be removed from the jaw assembly **600**. It will be appreciated that additional manufacturing steps may be undertaken after the bonding process is completed, prior to the release of the jaw assembly **600** from the fixture **780**. In some embodiments, after the bonding process is completed, the pivot pin **603** may be removed and the jaws separated, if desired, for assembly or further processing.

In some embodiments, the fixture **780** includes a shaft **782**, a first leg member **783** disposed at a first end **781a** of the shaft **782**, and a second leg member **785** disposed at a second end **781b** of the shaft **782**. First leg member **783** and the second leg member **785** may extend in a substantially perpendicular direction away from the shaft **782**, such that the fixture **780** may have a generally U-like shape. In some embodiments, the shaft **782**, the first leg member **783** and the second leg member **785** are integrally formed. In some embodiments, the first leg member **783** includes a first tip portion **784** and the second leg member **785** includes a second tip portion **786**. In some embodiments, the shaft **782**, the first leg member **783**, the first tip portion **784**, the second leg member **785** and the second tip portion **786** may be configured such that the fixture **780** has a generally C-like shape. Fixture **780** could be formed in a variety of shapes suitable to constrain the jaw members adequately during completion of the bonding process. Fixture **780** may be made from metal, plastic, ceramic and/or other suitable materials with desired properties, e.g., machinability, flexibility, moldability, temperature resistance, chemical resistance, etc. Fixture **780** and/or the jaw members may include features to enable quick, accurate, secure and reliable holding, including without limitation flats, slots, holes, grooves, recesses, pins, stops or any other suitable features that provides alignment and/or mating engagement of the fixture **780** to the jaw members. In some embodiments, either one (or both) of the jaw members may include one or more grooves or recesses defined therein configured and disposed to accept or matingly engage with one or more edge portions or protrusions formed on the first tip portion **784** and/or the second tip portion **786** of the fixture **780**.

FIG. 8 shows a bilateral end effector assembly **800** that includes an electrically-insulative hinge **850** that is configured to provide electrical isolation of the first and second jaw members **810** and **820**. Electrically-insulative hinge **850** is formed from a suitable electrically-insulative material, and includes an aperture defined therein. FIG. 9 is a side-view of

the end effector assembly **800** illustrating the second jaw member **820**, pivot pin **803**, and electrically-insulative hinge **850**.

In the embodiment shown in FIGS. 8 and 9, the electrically-insulative hinge **850** is bonded or otherwise securely attached to the second jaw member **820**, e.g., using an adhesive material **813**. Alternatively, the electrically-insulative hinge **850** may be attached to the first jaw member **810**. Electrically-insulative hinge **850** may be attached to the first jaw member **810** or the second jaw member **820** using any suitable material or bonding process.

As shown in FIG. 8, the pivot pin **803** is received by an aperture defined in the electrically-insulative hinge **850** and a pivot hole defined in the first jaw member **810**. In some embodiments, the pivot pin **803** is secured by a fastener **804**, e.g., a pin, cap, shoulder, rivet, swage, nut, etc. In some embodiments, the first jaw member **810** and the electrically-insulative hinge **850** that is attached to the second jaw member **820** are spaced apart by a gap **816**, e.g., to reduce friction and thereby minimize wear.

As shown in FIGS. 10 and 12, jaw member **110** also includes a jaw housing **116** that includes an insulative substrate or insulator **114** and an electrically-conductive surface **112**. Insulator **114** is configured to securely engage the electrically-conductive sealing surface **112**. This may be accomplished by stamping, by overmolding, by overmolding a stamped electrically-conductive sealing plate and/or by overmolding a metal injection molded seal plate. For example and as shown in FIG. 12, the electrically-conductive sealing plate **112** includes a series of upwardly extending flanges **111a** and **111b** that are designed to matingly engage the insulator **114**. Insulator **114** includes a shoe-like interface **107** disposed at a distal end thereof which is configured to engage the outer periphery **116a** of the housing **116** in a slip-fit manner. The shoe-like interface **107** may also be overmolded about the outer periphery of the jaw **110** during a manufacturing step. Lead **311** terminates within the shoe-like interface **107** at the point where the lead **311** electrically connects to the sealing plate **112**. The movable jaw member **110** is configured with a wire channel **113** to guide the cable lead **311** into electrical continuity with the sealing plate **112**.

As best shown in the exploded view of FIG. 12, jaw members **110** and **120** are pivotably mounted with respect to one another such that the jaw member **110** pivots in a unilateral fashion from a first open position to a second closed position for grasping and manipulating tissue **1420** (shown in FIG. 14). Fixed jaw member **120** includes a pair of proximal, upwardly extending flanges **125a** and **125b** that define a cavity **121** configured to receive the pivot flange **118** of the movable jaw member **110** therein. Each of the flanges **125a** and **125b** includes an aperture **101a** and **101b**, respectively, defined therethrough that secures the pivot pin **103** on opposite sides of a pin slot or opening **119** disposed within the jaw member **110**.

Jaw member **110** includes a pivot flange **118**. Protrusion **117** extends from the pivot flange **118** and includes an arcuately-shaped inner surface **111** configured to matingly engage the aperture **62** of sleeve **60** upon retraction thereof. Pivot flange **118** includes an opening **119** defined therein that is configured to allow the pivot pin **103** to pass therethrough, e.g., to allow jaw member **110** to rotate relative to jaw member **120** upon retraction of the reciprocating sleeve **60**. In some embodiments, the pivot pin **103** mounts to the electrically-insulative hinge **450** through a pair of apertures **451** defined therein and mounts to the stationary jaw member **120** through a pair of apertures **101a** and **101b** disposed within a proximal portion of the jaw member **120**.

11

Jaw member **120** fixes to the end of a rotatable tube **160** (shown in FIGS. **2** and **3**) which is part of the rotatable assembly **80** such that rotation of the tube **160** will impart rotation to the end effector assembly **100**. As shown in FIG. **2**, the distal end of the tube **160** is generally C-shaped to include two upwardly extending flanges **162a** and **162b** that define a cavity **165** for receiving the proximal end of the fixed jaw member **120** inclusive of C-shaped cuff **170** and slide pin **171**. The tube cavity **165** retains and secures the jaw member **120** in a friction-fit manner; however, the jaw member **120** may be welded to the tube **160** depending upon a particular purpose. Tube **160** also includes an inner cavity **169** (shown in FIG. **3**) defined therethrough that reciprocates the knife assembly **180** upon distal activation thereof and an elongated guide rail **163** that guides the knife assembly **140** during distal activation. The proximal end of tube **160** includes a laterally-oriented slot **168** that is designed to interface with the rotating assembly **80**, as described in the above-mentioned, commonly-assigned U.S. Pat. Nos. 7,150,097, 7,156,846, 7,597,693 and 7,771,425.

Jaw member **120** includes a rear C-shaped cuff **170** having a slot **177** defined therein which is configured to receive a slide pin **171**. Slide pin **171** includes a slide rail **176** that extends substantially the length thereof, configured to slide into friction-fit engagement within slot **177**. A pair of chamfered plates **172a** and **172b** extends generally radially from the slide rail **176** and include a radius that is substantially the same radius as the outer periphery of the rotatable tube **160** such that the shaft **12** can encompass each of the same upon assembly. The chamfered plates **172a** and **172b** also form a wire channel **175** that is configured to guide the cable lead **311** from the tube **160** and into the movable jaw member **110** (see FIG. **12**). Lead **311** carries a first electrical potential to movable jaw **110**. The electrically-conductive surface **112** and the insulator **114**, when assembled, include a longitudinally-oriented channel **115a** defined therethrough for reciprocation of the knife blade **185**.

Jaw member **120** includes similar elements to jaw member **110** such as jaw housing **126** having an insulator **124** and an electrically-conductive sealing surface **122** that is configured to securely engage the insulator **124**. Likewise, the electrically-conductive surface **122** and the insulator **124**, when assembled, include a longitudinally-oriented channel **115b** defined therethrough for reciprocation of the knife blade **185**. Knife channel **115** (made up of half channels **115a** and **115b**) is blocked when the jaws members **110** and **120** are opened and aligned for distal activation when the jaw members **110** and **120** are closed.

Jaw member **120** is connected to a second electrical potential through tube **160** which is connected at its proximal end to a lead (not shown). Fixed jaw **120** may include a fuse clip, spring clip or other electro-mechanical connection. In some embodiments, at least one jaw member, e.g., **120**, includes a stop member **750** that limits the movement of the two opposing jaw members **110** and **120** relative to one another. Stop member embodiments and internal electrical connections of the forceps **10** are described in the above-mentioned, commonly-assigned U.S. Pat. Nos. 7,150,097, 7,156,846, 7,597,693 and 7,771,425. As best shown in FIG. **2**, the rotatable tube **160** includes an elongated guide slot **167** disposed in an upper portion thereof and configured to carry lead **311** therealong.

Proximal movement of the tube **60** engages detent **117** to pivot the jaw member **110** to a closed position. It is understood from FIG. **12** that the jaw member **120** is stationary.

FIG. **14** shows the end effector assembly **100** of FIG. **1** shown grasping tissue **1420**. In some embodiments, the end effector assembly **100** may include a gap distance "G"

12

between opposing sealing surfaces **112** during sealing, e.g., in the range from about 0.001 inches to about 0.006 inches. In some embodiments, the end effector assembly **100** includes a gap distance "G" between opposing sealing surfaces **112** during sealing that ranges from about 0.002 to about 0.003 inches. As shown in FIG. **16**, the forceps **10** is insertable through a cannula **500** into a patient's body for use during a procedure.

As energy is being selectively transferred to the end effector assembly **100**, across the jaw members **110** and **120** and through the tissue **1420**, a tissue seal **1450** forms isolating two tissue halves **1420a** and **1420b** (see FIG. **15**). The knife assembly **180** which, when activated via the trigger assembly **70**, progressively and selectively divides the tissue **1420** along a tissue plane in a precise manner to divide the tissue **1420** into two sealed halves (not shown). Once the tissue **1420** is divided into tissue halves, the jaw members **110** and **120** may be opened by re-initiation or re-grasping of the handle **40**.

Hereinafter, methods of manufacturing an end effector assembly are described with reference to FIGS. **17** through **19**. It is to be understood that the steps of the methods provided herein may be performed in combination and in a different order than presented herein without departing from the scope of the disclosure.

FIG. **17** is a flowchart illustrating a method of manufacturing an end effector assembly **100** according to an embodiment of the present disclosure that includes a first jaw member **110** and a second jaw member **120**. In some embodiments, the first and second jaw members **110**, **120** are configured to be pivotably mounted with respect to one another.

In step **1710**, a first jaw member **110** is provided. The first jaw member **110** includes a pin slot or opening **119** defined therethrough.

In step **1720**, a second jaw member **120** is provided. The second jaw member **120** includes one or more pivot holes **101a**, **101b** defined therethrough.

In step **1730**, an electrically-insulative hinge **450** is provided that is configured to electrically isolate the jaw members from one another. The electrically-insulative hinge **450** is formed from a suitable electrically-insulative material. The electrically-insulative hinge **450** includes one or more pivot-hole locators **454** defined therein, and may take any suitable shape.

In some embodiments, the electrically-insulative hinge **450** includes a generally U-shaped body member **452** and two end portions **453a**, **453b** disposed at the opposite ends of the body member **452**. One or more of the end portions **453a**, **453b** includes an aperture **451** defined therein configured to receive a portion of a pivot pin **103** therein. In some embodiments the one or more pivot-hole locators **454** are defined by the one or more end portions **453a**, **453b** that include the aperture **451**.

In step **1740**, the electrically-insulative hinge **450** is attached to the first jaw member **110** such that the one or more pivot-hole locators **454** align with the one or more pivot holes **101a**, **101b** of the second jaw member **120**. The electrically-insulative hinge **450** may be bonded or otherwise securely attached the first jaw member **110** using any suitable material or bonding process, e.g., adhesive bonding, soldering, brazing, overmolding, mechanical interlock, snaps, bent tabs, etc.

In step **1750**, the first and second jaw members **110**, **120** are pinned via the one or more pivot-hole locators **454** and the one or more pivot holes **101a**, **101b** such that the first and second jaw members **110**, **120** are pivotably mounted with respect to one another.

13

FIG. 18 is a flowchart illustrating a method of manufacturing an end effector assembly 100 according to an embodiment of the present disclosure. In step 1810, a first jaw member 110 is provided. The first jaw member 110 includes a pin slot or opening 119 defined therethrough.

In step 1820, a second jaw member 120 is provided. The second jaw member 120 includes one or more pivot holes 101a, 101b defined therethrough.

In step 1830, an electrically-insulative hinge 450 is provided that is configured to electrically isolate the jaw members from one another. The electrically-insulative hinge 450 includes one or more pivot-hole locators 454 having an aperture 451 defined therein.

In step 1840, the electrically-insulative hinge 450 is attached to the first jaw member 110 such that the aperture 451 of the one or more pivot-hole locators 454 aligns with the one or more pivot holes 101a, 101b of the second jaw member 120. The electrically-insulative hinge 450 may be bonded or otherwise securely attached the first jaw member 110 using any suitable material or bonding process.

In step 1850, a pivot pin 103 is provided. The pivot pin 103 is configured to pass through the pin slot or opening 119 and to be received by the one or more pivot holes 101a, 101b.

In step 1860, the pivot pin 103 is inserted into the one or more pivot holes 101a, 101b and the aperture 451 of the one or more pivot-hole locators 454 such that the first and second jaw members 110, 120 are pivotably mounted with respect to one another.

FIG. 19 is a flowchart illustrating a method of manufacturing an end effector assembly 100 according to an embodiment of the present disclosure. In step 1910, a first jaw member 110 is provided. The first jaw member 110 includes a pin slot or opening 119 defined therethrough.

In step 1920, a second jaw member 120 is provided. The second jaw member 120 includes one or more pivot holes 101a, 101b defined therethrough.

In step 1930, an electrically-insulative hinge 450 is provided that is configured to electrically isolate the jaw members from one another. The electrically-insulative hinge 450 includes one or more pivot-hole locators 454 defined therein.

In step 1940, the electrically-insulative hinge 450 is attached to the first jaw member 110 such that the one or more pivot-hole locators 454 align with the one or more pivot holes 101a, 101b of the second jaw member 120. The electrically-insulative hinge 450 may be bonded or otherwise securely attached the first jaw member 110 using any suitable material or bonding process.

In step 1950, a holding fixture 780 is provided. The fixture 780 is configured to releasably hold the first jaw member 110 in contact with the second jaw member 120. In some embodiments, the fixture 780 is configured to hold the first and second jaw members 110, 120 in proper alignment while the electrically-insulative hinge 450 is fastened and/or cured to the first jaw member 110 (or the second jaw member 120). In some embodiments, the fixture 780 is configured to hold the sealing surface 112 of the first jaw member 110 directly against the sealing surface 122 of the second jaw member 120 in proper alignment while the electrically-insulative hinge 450 is fastened and/or cured to the first jaw member 110 (or the second jaw member 120).

In step 1960, a pivot pin 103 is provided. In some embodiments, the pivot pin 103 is configured to pass through the pin slot or opening 119 and to be received by the one or more pivot holes 101a, 101b.

In step 1970, the fixture 780 is releasably coupled to the first and second jaw members 110, 120. In some embodiments, the jaw member 110 and/or the jaw member 120 may

14

include one or more grooves or recesses defined therein configured and disposed to accept or matingly engage with one or more edge portions or protrusions formed on a first and tip portion 784 and/or a second tip portion 786 of the fixture 780.

In step 1980, the pivot pin 103 is inserted into the one or more pivot holes 101a, 101b and the one or more pivot-hole locators 454 such that the first and second jaw members 110, 120 are pivotably mounted with respect to one another.

In some embodiments, after the pivot pin 103 is inserted into the one or more pivot holes 101a, 101b and the one or more pivot-hole locators 454, in step 1980, and after the bond between the electrically-insulative hinge 450 and the first jaw member 110 is completed, the first and second jaw members 110, 120 are released from the fixture 780, in step 1990. It will be appreciated that additional manufacturing steps may be undertaken after the step 1980, prior to the release of the first and second jaw members 110, 120 from the fixture 780.

The presently-disclosed bipolar forceps is capable of directing energy into tissue, and may be suitable for use in a variety of procedures and operations. The above-described bipolar forceps embodiments may utilize both mechanical clamping action and electrical energy to effect hemostasis by heating tissue and blood vessels to coagulate, cauterize, cut and/or seal tissue. The jaw assemblies may be either unilateral or bilateral. The above-described bipolar forceps embodiments may be suitable for utilization with endoscopic surgical procedures and/or hand-assisted, endoscopic and laparoscopic surgical procedures. The above-described bipolar forceps embodiments may be suitable for utilization in open surgical applications.

Although embodiments have been described in detail with reference to the accompanying drawings for the purpose of illustration and description, it is to be understood that the inventive processes and apparatus are not to be construed as limited thereby. It will be apparent to those of ordinary skill in the art that various modifications to the foregoing embodiments may be made without departing from the scope of the disclosure.

What is claimed is:

1. An end effector assembly suitable for use with a forceps, comprising:

opposing first and second jaw members pivotably mounted with respect to one another, wherein the first jaw member defines at least one pivot hole configured to receive a portion of a pivot pin therein; and

an electrically-insulative hinge defining at least one pivot-hole locator, wherein the electrically-insulative hinge is fixedly bonded to the second jaw member such that the at least one pivot-hole locator aligns with the at least one pivot hole defined in the first jaw member, wherein the electrically-insulative hinge electrically isolates the jaw members from one another and includes a U-shaped body member having an entirely closed proximal end and an open distal end.

2. The end effector assembly of claim 1, wherein the first jaw member is a fixed jaw member and the second jaw member is a movable jaw member.

3. The end effector assembly of claim 1, wherein the electrically-insulative hinge includes first and second end portions disposed at opposite ends of the U-shaped body member.

4. The end effector assembly of claim 3, wherein the first end portion includes an aperture defined therein configured to receive the pivot pin therethrough and the second end portion includes an aperture defined therein configured to receive the pivot pin therethrough.

15

5. The end effector assembly of claim 1, wherein the U-shaped body member includes a proximal backspan and a leg extending distally from each end of the proximal backspan.

6. The end effector assembly of claim 1, wherein a proximal backspan closes the proximal end of the U-shaped body member.

7. A bipolar forceps, comprising:

a housing;

a shaft extending from the housing and including a distal end configured to support an end effector assembly;

the end effector assembly including:

opposing jaw members pivotably mounted with respect to one another, each of the jaw members including a sealing surface associated therewith, the jaw members moveable from a first position in spaced relation relative to one another to at least one subsequent position wherein the sealing surfaces cooperate to grasp tissue therebetween; and

an electrically-insulative hinge including at least one pivot-hole locator having an aperture defined therein, the electrically-insulative hinge fixedly bonded to one of the jaw members such that the aperture of the at least one pivot-hole locator aligns with a pivot hole defined in the opposing jaw member, wherein the electrically-insulative electrically isolates the jaw members from one another and includes a U-shaped body member having a closed proximal end and two legs extending from the proximal end to an open distal end, the distal end of each leg disconnected from the other leg.

8. The bipolar forceps of claim 7, wherein each jaw member is adapted to connect the sealing surface associated therewith to an electrosurgical generator such that the sealing surfaces are capable of conducting electrosurgical energy through tissue grasped therebetween.

16

9. The bipolar forceps of claim 7, wherein the opposing jaw members of the end effector assembly include a fixed jaw member mounted in fixed relation to the shaft and a movable jaw member mounted about a pivot pin coupled to the stationary jaw member.

10. The bipolar forceps of claim 9, wherein the fixed jaw member includes a pair of proximal, upwardly extending flanges that define a cavity configured to receive a flange of the movable jaw member therein.

11. The bipolar forceps of claim 7, wherein the electrically-insulative hinge includes first and second end portions disposed at opposite ends of the U-shaped body member.

12. The bipolar forceps of claim 11, wherein the first end portion includes an aperture defined therein configured to receive a portion of the pivot pin therein.

13. The bipolar forceps of claim 12, wherein the second end portion includes an aperture defined therein configured to receive a portion of the pivot pin therein.

14. An end effector assembly suitable for use with a forceps, comprising:

opposing first and second jaw members pivotably mounted with respect to one another, the first jaw member being a fixed jaw member and the second jaw member being a movable jaw member, the first jaw member defining a pivot hole configured to receive a portion of a pivot pin therein; and

an electrically-insulative hinge defining a pivot-hole locator, the electrically-insulative hinge fixedly bonded to the second jaw member such that the pivot-hole locator aligns with the pivot hole defined in the first jaw member, the electrically-insulative hinge electrically isolating the first and second jaw members from one another, the electrically insulative hinge having an entirely closed proximal end and an open distal end.

* * * * *